

cinefex

number 10
\$4.75



cinefex

...the journal of cinematic illusions

editor & publisher
Don Shay

contributing editors
Paul Mandell
Jordan Fox

circulation manager
JoDyne Shay

editorial consultant
Robert F. Everett

editorial services
Ann Dreda

CINEFEX 10 — October 1982. Published quarterly at P.O. Box 20027, Riverside, California 92516. Subscription rates (U.S. only): four issues — \$12; ten issues — \$25. Return postage must accompany all unsolicited manuscripts, photos or other materials. Printed by Valley Printers, Sunnymead, California; typesetting by The Set-Up, Riverside, California; color separations by Vini-Colour, Covina, California. Contents copyright © 1982 by Don Shay. All rights reserved. Reproduction in whole or in part without permission is prohibited.

Poltergeist — Stilling the Restless Animus 4

When producer Steven Spielberg decided to raise hell in suburbia, he presented the cinemagicians of Industrial Light and Magic with their most formidable assignment to date. *Poltergeist* visual effects supervisor Richard Edlund, along with a dozen key members of his ILM effects unit, discusses the arduous creation of ghosts and goblins, passageways into other dimensions, imploding houses and numerous other paranormal phenomena. In addition, mechanical effects supervisor Michael Wood explains the complexities involved in bringing menacing trees to life and in trying to defy gravity, while Craig Reardon discusses the film's queasy makeup effects. *Article by Paul Mandell.*

Mach 5 Effects — The Apogee of Firefox 40

Extraordinary challenges foster extraordinary ingenuity and innovation. Such was the case when superstar producer-director Clint Eastwood approached Apogee, Inc. with his *Firefox* project. As scripted, the film included a pivotal effects sequence featuring a fictitious pair of shiny metallic warplanes engaged in aerial combat against an optically foreboding environment of bright skies and sunlit clouds. Apogee rose to the challenge by completely rethinking the basic tenets of traditional traveling matte work and devising an altogether new process, along with a number of auxiliary technologies and techniques designed to suspend audience disbelief. Effects producer John Dykstra, and seven key members of the Apogee team discuss the highs and lows of the landmark production. *Article by Paul M. Sammon.*

FRONT COVER — An evil specter menaces the Freeling household in *Poltergeist*.
A hijacked MIG-31 lands on an ice floe to refuel in *Firefox* — BACK COVER.



POLTERGEIST

stilling the restless animus

article by Paul Mandell

Picture, if you will, a large building, eighty-four feet wide and ninety-two feet long. There are no windows visible inside — black drapes shroud the walls. In one corner, a small army of twisted, transparent hands beckon insidiously; in another, a gaping esophagus convulses in peristaltic spasms. From within its obscene depths, a snake-like tongue whips forth and crawls about, searchingly. The noise is terrific. Somewhere in this Hadesian blaze, a door frame splits apart with titantic force. A large skull enveloped by rotting flesh lurches forward, its eyeballs burning with light, while elsewhere a spidery monstrosity leers hideously from a water-filled glass tank. Above, a large membrane hangs from the ceiling, oozing vile, gelatinous ichor when pierced by falling bodies plummeting through it like a bat out of hell.

What reads as a bad day in a Coney Island funhouse, or the world's worst Freudian nightmare, is only business as usual at Industrial Light and Magic for Steven Spielberg's production of *Poltergeist*. The building described above, a sound stage facility baptized by effects supervisor Richard Edlund (ASC) and company for the film, is nestled in the hills of Marin County, a far cry from the River Styx. Yet the project was not without its hellish moments. With *Poltergeist* being a patchwork of nearly every conceivable special effect, Edlund and optical chieftan Bruce Nicholson will readily affirm that it was ILM's toughest assignment to date.

The handwriting was on the wall, though. When little Carey Guffey eyeballed the awesome light spilling under his door in *Close Encounters*, it seemed inevitable that Steven Spielberg would connect cherubic tots with nightmare images and whip up an audaciously unnerving experience, requiring the utmost in technical know-how. Possibly influenced by the *Twilight Zone* episode "Little Girl Lost" — in which a small child crawls out of bed and enters, through her bedroom wall, a Caligariesque other dimension — Spielberg hammered out an original scenario which, although smacking of *Close*

Encounters, *The Exorcist* and other generic influences, was nonetheless a unique and enthralling piece of showmanship. Despite Tobe Hooper's titular role as director, the film abounds with evidence of Spielberg's personal touch — a situation which was to be the focus of considerable media attention at the time of its release. As author, producer and overall designer, the ballsy cinematic superstar pulled no punches in spiking his suburban tale of terror with a horde of visceral images. His goal? To scare the be-Jesus out of you.

"*Poltergeist* and *E.T.* were coming in at the same time," Richard Edlund recalled. "We had heard that Steven was doing two pictures essentially at once. Recovering from *that* thought, it became fairly obvious that the motion control aspects of *E.T.* were well within Dennis Muren's area of expertise, while the range of oddball approaches that needed to be devised for *Poltergeist* tended to be more up my alley. I read the script and liked it from the start. There were only a few things that in my opinion were unnecessary: and oddly enough, those things were dropped out. At any rate, it left a very interesting survey of problems — what producer Frank Marshall calls 'the \$250,000 sentence,' where you're reading the script and it casually says: 'All of a sudden, the house implodes.' That stops you dead in your tracks! Knowing that Steven is a visually acute person, and isn't prone to accepting anything that doesn't work for him, really made us sweat."

Poltergeist came right on the heels of *Raiders of the Lost Ark*. Edlund, in fact, was at M-G-M timing *Raiders* between takes of *Poltergeist* on the neighboring soundstages. The situation in May 1981 was made even more problematic by an anticipated director's strike threatening the industry. "Everyone was afraid to start a picture," said Edlund. "No one wanted their director walking off. When that happens, the picture is halted for an undetermined period of time and the crew is laid off immediately. Then, when you start up again, a lot of the original people have gone on to other projects. So you wind up with a disjointed production. *Poltergeist* was rushed into production in order to secure the necessary plates. That way, even if the strike happened, we'd still be able to continue the effects end of it."

During the weeks embracing the wrap of *Raiders*, Spielberg arrived with his rewrite of *Poltergeist*, based on a collaboration with Mark Victor and Michael Grais. The complex logistics of the *Raiders*/*Poltergeist* overlap were lubricated by Frank Marshall, Spielberg's energetic co-producer who spearheaded both projects. The hustle to get *Poltergeist* rolling, however, put ILM in the peculiar position of cooking up an effects budget blind.

"When we got the script," said Edlund, "we only had a few weeks to put that budget together. Tom Smith (ILM's production supervisor) and I spent a lot of time wondering how we were going to develop a budget for a film whose effects had yet to be decided on — especially since nearly everything was going to require R&D. Essentially, though, we were given a basic figure to work with, with the idea that it might be jacked up as we went along. So from that, we knew how much we could figure on being able to spend, and how much time we'd have, and how many people we could assign to the project. The budget started making sense as we went along. We worked ten months on approximately a hundred and forty shots. And they *had* to be convincing, which is always a little intimidating when you're fighting a predetermined release date."

Edlund commuted back and forth to M-G-M from mid-May to the end of July, overseeing the live-action shoot and weeding out potential trouble spots. "On the plates," he pointed out, "there are

certain cardinal rules that you don't violate. The shot has to be steady: it has to be lit and exposed correctly. If you have those things under control and you later find flaws in the scene, there's always a way to fix them. Steven would make a lot of decisions on the spot and improvise. We'd talk things over and he'd say: 'Yeah, that's good. We'll shoot it this way. We're gonna have to hang those lights in there; and those wires are thick, but we'll figure out some way later on to get rid of them.' Actually, we discovered that you can fix anything over a period of time — provided the money is there." Assisting Edlund on the plate photography were ILM cameramen Bill Neil and Jim Veilleux. When Veilleux shuttled over to *Star Trek II*, Rick Fichter stepped in, sharing most of the effects photography with Neil for the duration of *Poltergeist*.

As *Poltergeist*'s effects art director, Nilo Rodis-Jamero was one of the film's key conceptualists. Having worked at ILM since *The Empire Strikes Back*, Rodis was in the midst of doing preproduction sketches for *Revenge of the Jedi* when George Lucas loaned him out to Spielberg. "As it turned out, I was literally running between *Poltergeist* and *Jedi*. Thank God, it was only a block away! I was holding two crews — two totally different needs and production goals. On *Jedi* I was doing costume design and wardrobe. It was: 'How does this material feel and hang?' And in the middle of this, I'm designing *the Beast* coming out of the hallway. The most fascinating thing about *Poltergeist* was that most of the effects had never been *done* before. We knew we could make spaceships and laser blasts, but how do you make a house implode? Every shot was R&D time. Consequently, the effects figure for *Poltergeist* was more than twice that of *E.T.*" Rodis and Edlund started planning *Poltergeist*'s effects at Spielberg's headquarters in Los Angeles. "When you're sitting with Richard and Steven, the ideas really roll. With Richard helming the technical end of the talk and Steven being in outer space, I became sort of a bridge between them. That was a very fulfilling role for me. Steven would talk about *the Beast* in the hallway in terms of: 'What does it look like?' Richard would talk in terms of: 'How are we going to shoot it?' The changes were continuous."

Rodis started redesigning the original storyboards from ILM's point of view, and rendered rough sketches for Spielberg's approval. These encounters often proved frustrating for Rodis because of Spielberg's involvement with *E.T.* and the ass-backwards approach to *Poltergeist*'s special effects. "There was a bit of distance between us and Steven. Since he seemed to be preoccupied by *E.T.*, it was sometimes a problem pulling him back to where we stood on *Poltergeist*. Very often he'd be talking about something that had nothing to do with the shot. Also, many of the shots were done before we had a solid idea of what was to be. I'm used to working with George Lucas or Irv Kershner, who actually plan it out ahead of time. Almost *always*, effects will dictate what's going to happen. *Poltergeist* was the other way around. We were told: 'Something is going to happen here, and this is the reaction. Give me a visual representation of what this is.' Bruce Nicholson and Richard Edlund would round-table it with me; I'd sit down and compose something, and send it to Steven. It became a guessing game after a while."

The ILM model shop found dealing with Spielberg more entertaining than confusing. Spielberg's esteem for Ridley Scott's *Alien* was no secret to anyone; and from the start, Spielberg was adamant on transposing the earlier film's organic look to *Poltergeist* — not only for the climactic esophagus sequence, but for the film's overall design. To convey ideas from his Los Angeles office, Spielberg would send video cassettes to ILM elaborating on the storyboards. According to modelshop supervisor Lorne Peterson, Spielberg's "instructional films" were tension-relieving laughfests. "In

some way, it reminded me of Coppola's electronic system of sitting in his trailer and sending videograms to all his underlings. Steven had a camera going on this little setup, and he'd put on little shows for us. Being an entertainer, he didn't do them straightforward. Instead, he'd have props and hand puppets and things to demonstrate what he wanted. They were really funny! He'd hold up a storyboard and say: 'Okay, here's where we want real drama — *real* organic goop. This one's drippy stuff *everywhere*. And here on this one, they're wetting their pants!' He'd break for lunch and announce, 'Okay, that wraps it up for *The Mr. Steven Show*.' And he'd hold up a little sign that said: 'Out to Lunch.'

"Spielberg was really into that organic stuff," Peterson related with mock nausea. "I thought of visiting slaughterhouses, picking up entrails and squid and things like that. But I remember Richard Edlund groaning: 'Oh, no. We *can't*!' With a live-action shot, you'd sweep the stuff out in an hour and someone would set up the next day's shot overnight with freshly butchered parts. We, on the other hand, had to be geared for a certain amount of repeatability under hot camera lights. Everyone was imagining this terrible organic stuff smelling up the place. For a while, we tried taking molds off things. We took molds off tripe and wound up with a *great* texture. We also did some octopus tentacles. But the end result lacked that real-life organic flop. When you cast it in rubber, it's too homogenous. Nor does a mold necessarily look organic. We found that out rather quickly."

No one took the day-to-day *Poltergeist* operation more seriously than visual effects coordinator Mitch Suskin. An alumnus of Spielberg's 1941 and the revised edition of *Close Encounters*, Suskin had been retained again on the director's subsequent *Night Skies* project. When *Night Skies* was aborted, Suskin shuttled over to *Poltergeist* at associate producer Kathleen Kennedy's request.

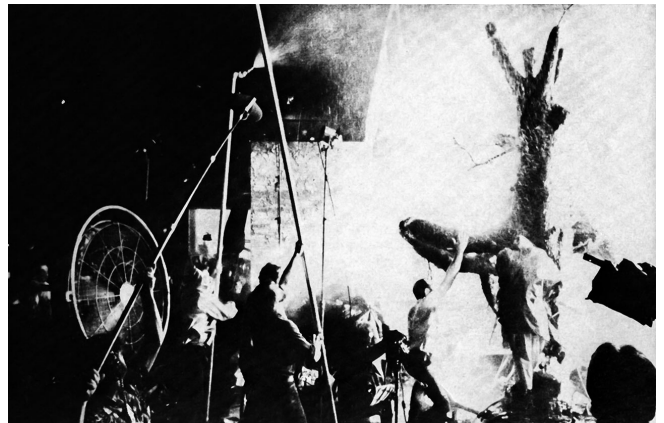
"My function on *Poltergeist* was to report back to Steven and Frank Marshall and organize the optical and practical effects. The first thing I did was break the script down into what might be opticals and mechanicals — to come up with a working *effects* script, one we could pass from department to department. And while I acted as a source authority on what we saw as an optical effect or as a stage responsibility, I was really more of an interpreter between the two camps — North and South, you know. When Richard Edlund came to M-G-M with an ILM camera crew, plates that were anticipated as opticals were shot in VistaVision. Whenever something was questionable, I'd make sure a protection plate was shot. One problem was the distances between M-G-M's production office and our work stages. We had tremendous problems with *mechanical* effects, mainly because Mike Wood and his crew were way out in Agua Dulce building them, and we didn't have the time or the personnel to run out there and keep tabs on things. We had *massive* problems with the tree — which should have been anticipated but weren't."



Michael Wood's mechanical effects crew constructed three versions of the giant tree which bursts through Robbie Freeling's window and forcibly drags the child from his bed. On the first, the two main branches drew together and pushed their way into the room. The second consisted only of the limbs, mounted on tracks. Actor Oliver Robins was placed in a flying harness to appear as though he were actually being carried away by the branches. The third was an outside static model which had an articulated orifice and oozed a slimy, saplike substance.

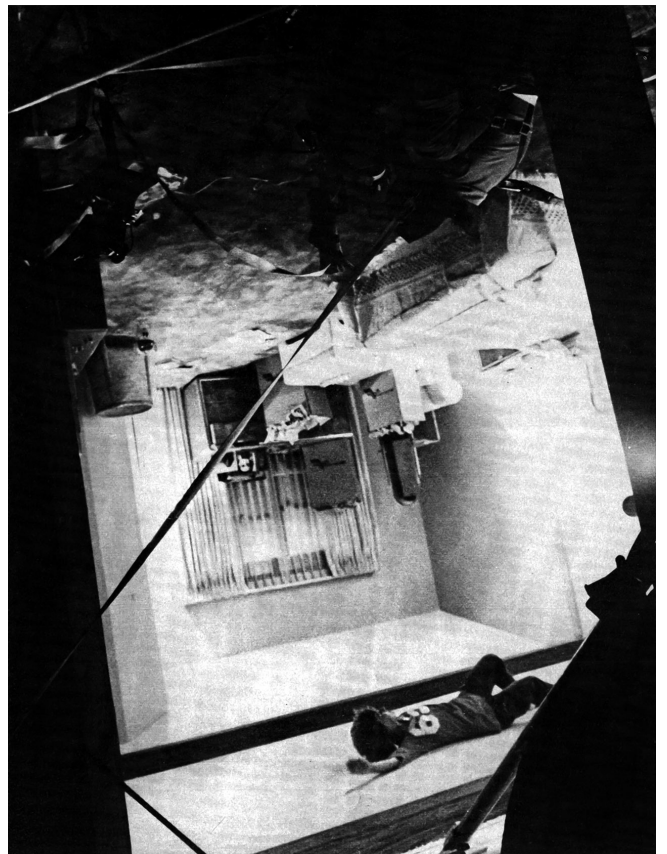
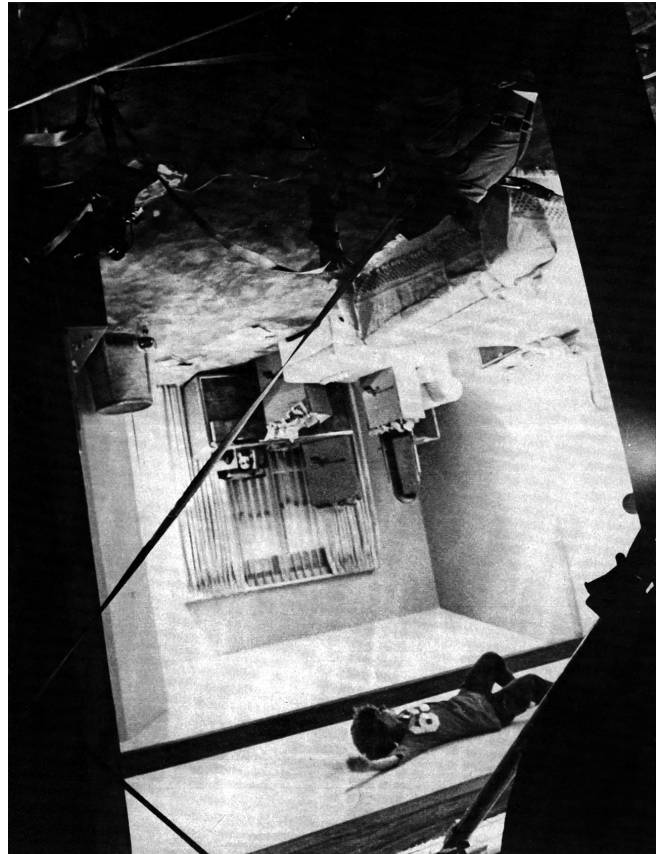


Michael Wood's mechanical effects crew constructed three versions of the giant tree which bursts through Robbie Freeling's window and forcibly drags the child from his bed. On the first, the two main branches drew together and pushed their way into the room. The second consisted only of the limbs, mounted on tracks. Actor Oliver Robins was placed in a flying harness to appear as though he were actually being carried away by the branches. The third was an outside static model which had an articulated orifice and oozed a slimy, saplike substance.



Michael Wood's mechanical effects crew constructed three versions of the giant tree which bursts through Robbie Freeling's window and forcibly drags the child from his bed. On the first, the two main branches drew together

and pushed their way into the room. The second consisted only of the limbs, mounted on tracks. Actor Oliver Robins was placed in a flying harness to appear as though he were actually being carried away by the branches. The third was an outside static model which had an articulated orifice and oozed a slimy, saplike substance.



A large gimbal rig was constructed for the scenes in which Diane Freeling is seized by unseen forces and drawn up the walls of her bedroom and across the ceiling. The full bedroom set was installed on the revolving gimbal and the

A large gimbal rig was constructed for the scenes in which Robbie Freeling is seized by unseen forces and drawn up the walls of her bedroom and across the ceiling. The full bedroom set was always on that portion of the room facing downwards. The gimbal rig was also used with the children's room when everything begins to slide into the closet.

Indeed, the ominous oak tree that bursts through Robbie Freeling's bedroom window was a source of heartburn for all concerned. "When we first discussed the tree," Suskin continued, "there was a question as to whether we'd have somebody sculpt one or use a real tree as a prototype. It turned out that we were able to locate a real tree, which was a great cost-saver, and we used that for making molds. But here we had a conceptual problem. Did we want to see one of the trees from *The Wizard of Oz* — faces, mouths and hands — or something more subtle? You always have problems drawing the line in anything like that. How far do you want to go to get the point across to the audience? We wanted something recognizable, but we didn't want a cartoon. Steven wanted it to break through the window and grab Robbie in one cut. But as it turned out, it wasn't mechanically feasible to build articulated tree branches that could do that all in one cut. So you have to decide how you want to cheat it. I think the mechanical effects crew came a little short of their goal. But the objective was extremely high. The way it was done, in segments, worked just as well as Steven's original idea."

Along with a multitude of other practical effects, the articulated tree was turned over to mechanical effects supervisor Michael Wood for design and construction. Even though his crewmembers were able to take molds off the real tree, they still ended up having to make many of their own parts. "It was a maze of pneumatic cylinders, electronic valves and foam rubber," Wood explained. "Cables went through the limbs' armature, enabling the fingers to move. The tree itself had a separate steel armature covered with foam and latex; the rigid parts were made of fiberglass. Cables were operated by pneumatic rams and electronic solenoid valves. We had joysticks that would control four limbs." The final effect called for three different trees. "The basic one came together and advanced into the room. Then we had just a set of arms with articulated branches that actually crashed through the window. They were on a rolling platform, and we used air mortars to break the glass. We put the boy in a flying harness, with the limbs themselves also attached to the harness so it would look like they were pulling him out. Finally, we had a full tree as a static model for the front yard. That one had an articulated mouth. We loaded it with honey and flour to simulate sap, hardly visible in the film. We also had a pressure pot containing 'super-goop,' thinned it down, and kept the pot going for a continuous slime effect." One deleted cut had the Freelings ensnared by enormous moving branches blocking the passageways outside the house. Spielberg felt it reduced the intensity of the sequence.

Another major project for the mechanical effects crew involved the construction of a massive gimbal rig that would allow for the complete rotation of the Freeling bedroom sets during the two

harrowing sequences in which the children's room is methodically sucked into its own closet and another in which Diane Freeling is inexorably drawn across her bedroom walls and ceiling by powerful, unseen forces. The idea had been derived ostensibly from the sequence in *Close Encounters* where Roy Neary's truck cab was mounted on a rotating gimbal to simulate momentary weightlessness, but similar mechanisms had been employed decades earlier in *Royal Wedding* — for Fred Astaire's ingenious dancing-on-the-walls routine — and later in *2001: A Space Odyssey*. "We were able to make one giant gimbal that could be shared by both the master bedroom and the kids' room," said Wood. "The sets were built on special platforms so the gimbal could just clamp on, top and bottom, and pivot the whole room. Then, by mounting the camera stationary to the gimbal, there was nothing to relate to the fact that it was actually turning. The gimbal was built in three sections and rigged with hydraulic motors so it could do a full 360 degrees. Each motor had 75,000 pounds of torque. The sets themselves sat on a platform that was thirty-by-thirty feet — with the corners cut off to facilitate the turning points for the gimbal." One of the most trying aspects of the gimbal-related shots was getting the contents of the children's room to slide toward the closet in some sort of sequence. Everything had to be rigged on trip wires. Conversely, for the master bedroom shots — where only Diane Freeling was *supposed* to be moving — extreme care had to be taken to glue or bolt everything into its proper gravity-based position, including such troublesome items as drapes and bedspreads.

"At times we got overwhelmed by fun effects and audacious ideas," Mitch Suskin remarked, "possibly more than the film required. The one scene that sticks in my mind is where Diane is pulled up the wall, across the ceiling, and down the other side. During that, there was going to be a kind of 'stain' in her path — something foreshadowing the closet turning into a mouth. It was a pulsating, organic, ugly thing. "The concept was eventually discarded, but not before the physical effects crew had gone ahead and built it and it went before the cameras. "We made a large latex bladder for the stain," Mike Wood related. "There were holes in the wall so we could actuate it manually from behind, and we had people strapped to the outside of the set, putting their hands through. During the scene, the stain was to have grown bigger and more amorphous, and the girl was supposed to roll through it from her bed." A more risqué notion was to be the violation of Diane Freeling by unseen forces as she involuntarily defied gravity in her upturned room. Wood contrived a special harness to facilitate "rape" movements in that position, but when the idea endangered the picture's PG rating, it, too, was scrapped. An alternate scene of Jobeth Williams writhing in bed remains in the film, but its darker implications are less apparent.

Another early participant in the *Poltergeist* effects work was special effects makeup artist Craig Reardon, whose involvement in the film would ultimately result in a strange series of convoluted production subplots. The young sculptor had worked with Rick Baker on Tobe Hooper's *Funhouse*, and had also been peripherally involved with Hooper's fiasco *Eaten Alive!* — so the director was not *alien* to him. When Hooper called him in for a meeting to discuss *Poltergeist*, Reardon was delighted — not only at the prospect of working once again with Hooper, whom he personally enjoyed, but also of being affiliated with a Steven Spielberg production.

"At the time," said Reardon, "Tobe said their major concern was to construct, somehow, an enormous grinning head that would come looming out of a bedroom closet. He placed such emphasis on this head in my briefing that I had the impression it was intended to be almost the

centerpiece of the film. It certainly sounded interesting enough — a head so enormous it could almost swallow you whole. I asked

Tobe if it could be created with grotesque makeup on a live actor. He said, no, it had to have a mouth which would open much further than a human being would be capable of doing. Also, a vast amount of light would pour from the mouth. Therefore I realized that I would need to build a cable-operated head. I'd worked around such constructions on several former jobs, but had never built one myself; but I naturally said *sure* I could do it, crossing my fingers furiously. Tobe also mentioned to me at this first meeting that there would be a need for some corpses, which would have to be capable of some movement. After talking with Tobe, I went in to see Frank Marshall, who is a very relaxed and likeable person. He seemed to like and trust me, so I was on — pending a talk with Steven Spielberg. I then met with Steven, who seemed to share Frank's willingness to give me a go, and that was that. This was the first picture of any prestige whose makeup effects I was put in charge of. I was somewhat intimidated, and to make points I tried to keep my expenses way down, which among other things meant having a crew of as few people as possible. As things worked out, I had a 'crew' of only one individual — Mike McCracken. He turned out to be all the crew I needed. Mike is a brilliant sculptor, and has an inventive mind and a delightful sense of humor. He helped me keep my wits and meet my deadlines in the hectic months to follow."

At the film's denouement, the Freeling property becomes a ghoulish tableau of cadavers — some bobbing up from the swimming pool excavation like rotten apples, others erupting from the ground in caskets. In only a matter of weeks, Reardon had to fabricate a brigade of corpses, rig them for movement, and be ready for location photography at a housing tract in Simi Valley, California, in May 1981.

"At the very beginning of our work schedule, Mike and I launched immediately into getting the corpses ready, because they were needed before anything else. I knew of a biological supply firm which offers actual human skeletons for use in high school and college science classes. These skeletons, interestingly enough, are imported from India, which I'm told is the only country in the world that will allow the export of human skeletons for commercial purposes. There was certainly no time to build skeletons from scratch, or even to take a mold off one. We needed to have thirteen whole skeletons delivered to us which we could then proceed to cover with fake rotten flesh and rig for movement. The same firm also offers plastic skeletons, but these are all uniform in appearance because they all come from one mold — and that wasn't in their favor for this project, because I figured the anomalies of real human skeletons would only enhance their realism. Another factor, believe it or not, was that the plastic variety cost more, evidently because of labor involved in molding the parts.

"I aimed for an exaggerated, horrible look. I'd studied a book of photographs of famous mummies of Guanajuato, Mexico, which are on display in a macabre gallery adjacent to a cemetery. They are certainly grotesque, but many of them have a rather harmless, desiccated look which I felt ran counter to what Spielberg and Hooper were looking to achieve in the climactic scenes. I felt that the 'best' looking skeletons in the Guanajuato book were those which appeared to be screaming in a particularly ghastly way — faces that suggest that the afterlife isn't all it's cracked up to be. So Mike and I used that look as a point of departure. I used a few approaches. In some cases I'd sculpt in wet clay directly over the skulls. We'd take our mold off that and cast foam rubber on the skull by

putting the skull back in the mold with foam and baking it in the oven. We used that approach for our 'key' characters. The others were built up in various ways. I took a couple extra castings of these foam skins and glued them to other skulls; but I would pull and distend them as I glued them in place, changing their appearance. I would also pluck pieces loose to indicate a different kind of disintegration. That way we got more mileage out of our sculpture work. Mike built some of the faces up out of scraps of foam or extra facial pieces from the molds. We had only a month to get these things ready for Simi Valley, so Mike and I really had to hustle. Mike began creating the rotten flesh on the bodies while I began to work on the rigging which would make the skeletons capable of movement. Except for a couple days when we were joined by our friend and colleague John Goodwin, Mike and I did all the work ourselves. Mike built the flesh using a clever technique of spreading foam rubber over torn and ragged tee shirts draped over the skeletons, which when the rubber was cured resembled flesh dried like beef jerky. He would then repeat the process until he'd achieved a wonderful labyrinth of desiccated flesh. Meanwhile, I did my rigging, and painted the completed corpses."

To economize on time, Reardon decided to rig six or seven skeletons, and exchange the heads if more than the seven were needed to appear to move. He designed a rigging system whereby the bones were animated by stout fishline, which was run through small eyelets glued to the bones and running tightly along them to a place on the shoulder blades where all the lines came together and could be run out of sight down the back. This way, the skeletons functioned like upside-down marionettes, with no exposed lines showing. "I was able to get the skeletons I rigged to flex their arms, rotate their wrists, and open and close their fingers. The heads could look up from the chest and look to either side, plus open and close their mouths." Reardon shuttled his gruesome stiffies over to Hooper and Spielberg at M-G-M, and both men beamed at the results. Hooper seemed especially pleased that his protege had paid off with some useable, offbeat material. "Tobe exclaimed to me in his Texas drawl: 'Gosh, man. I just asked you to make 'em move a little bit — not resurrect 'em!' He was clearly tickled. The irony of all this is that during filming, we either had no access possible for the operating lines, as in the pool scenes, or very limited access, as when the corpses were installed in the caskets, and so could make very little use of all the exhaustive rigging."



For the Grand Guignol finale, thirteen disinterred corpses — in varying states of decomposition — were fabricated over real skeletons by effects makeup artist Craig Reardon and associate Mike McCracken. Foam rubber and strips of fabric were formed and baked together to create the look of rotting flesh.

The corpses were duly readied for their Simi Valley location debut, and were delivered and installed in coffins which had already been buried around the chosen tract home by Mike Wood's physical effects crew. During the night shooting, the caskets were ejected from the ground. "The storyboards included one shot of a lady cadaver which would blow out of a casket and hit Teague, the developer, right in the kisser," Reardon recalled. "Tobe had an idea which wasn't very practical, but was delightfully bent. He requested we place an equally dead and dried up pet cat in the arms of this woman. A lovely detail, but when it came to filming it, the casket emerged from the ground with a roar and a huge wall of billowing dirt — reminding me of an episode of *Combat* with those mortars going off everywhere — and when the dust settled, you saw a little heap lying there, which was the lady cadaver and her pet pussycat. Ultimately, it all got edited out of the picture, anyway."

When it came time to do the pool sequence — shot later at the studio — Reardon and McCracken once more felt the pinch of hurried scheduling. To their chagrin, there was no time to confer with the physical effects crew as to how the corpses should be suspended and operated in the water. Reardon had constructed wooden 'bobbing machines' designed to elevate and bob the corpses in the water, and also to anchor the lines controlling the movements of the arms and head. These had to be abandoned when it was discovered on the day of filming that unforeseen friction developed in the wet operating lines, complicated further by simple space constrictions and the added weight of the wet corpses and their ragged wardrobes. As a result, the cadavers had to be animated by hand, with a minimum of string pulling. Even Reardon was surprised at how wide the pool shots looked in the release prints, considering the close proximity between him and his crew, and the screaming Jobeth Williams. "We were reaching our corpses in from as far back as we could get, and keeping ourselves submerged as much as possible. The special effects rain felt like ice water, and when Steven Spielberg or Tobe Hooper called down a request, I always replied with chattering teeth. But as Steven said one day: 'C'mon, Craig. This is why you got into movies, isn't it? The glamour?'" The only shot which was a bit difficult to time was the first shot, when Jobeth Williams emerges from the water, followed shortly by a corpse. "It kind of bobs up and kisses her on the neck. That was filmed several times in order to get the most intimate contact and scary effect."



At director Tobe Hooper's suggestion, Reardon fashioned a similarly desiccated cat as an eternal companion for one of his gruesome creations.



Diane Freeling slips and falls into the storm-flooded pool excavation, only to find herself surrounded by a horde of grisly corpses.



The pool corpses were wire-rigged with articulating devices which proved largely unworkable in close quarters, especially when the mechanisms became waterlogged. As a result, most of the actuating was done manually. Up to his neck in muddy water, Craig Reardon manipulates one of his charges for Jobeth Williams, while associate John Goodwin moves another in from behind.

Careful camera alignment kept the effects technicians out of the frame. Reardon poses with a plateful of his molded vinyl which erupts from the “cancerous” steak.

Mike Wood engineered an additional pool effect that was never used. Skulls were encased in latex and inflated into balloons, then placed underwater. The balloon would surface slightly and blend in with the muddy water. On cue, the latex would be punctured from below and the skulls would pop hideously. “It was quite a shocker,” said Wood, “but time prevented us from completing the scene.”

“By the time we were all done,” remarked Reardon, “those pool corpses looked like Hungarian chicken soup, which has all the bones still in it. They were almost liquefied. One of them was an unused leftover from a film I once did called *The Unseen*. Mike and I had pet names for all the cadavers, and this one was named Jeeves because of the formal attire — like a butler’s suit — he was dressed in as he hung around our shop. At one point in the pool, Mike tapped me on the shoulder and said, “Say goodbye to Jeeves.’ I looked over at Jeeves — who unlike the others had a papier mache face — just in time to see his pulpy face slide right off his plastic Revell skull and into the water.” Fortunately, Reardon and McCracken had a few cadavers in reserve for the final eruptions in the kitchen and on the front porch.

Concurrent with wrangling corpses, Reardon had several other responsibilities. “I soon learned about another item, which was the steak. The script said it should erupt with cancerous tissue. I had horrible visions of something you’d have to inflate, with tendrils and God-knows-what. At one point, M-G-M sent over a photo of a macrophage, which is a microscopic organism present in the body’s natural defense system and which looks like it could have starred in *Outer Limits*. This was what Tobe thought the steak could grow to look like as it became cancerous and deformed. Therefore I went ahead and sculpted it, a ghastly thing with tentacles, lumps and bumps — all of it four times the size of a New York steak. Steven Spielberg saw it and said: ‘No, no. Not for the steak. But this looks like it might be good for the stain on the wall.’ After working furiously and getting my first steak vetoed, I realized Steven was calling the creative shots; so with all deference to Tobe, who had some excellent ideas, I made certain to approve everything with Steven before investing hours of precious time.” With the macrophage concept canned, Reardon was on his own. “Steven said: ‘Please, just make it look like a steak; but have something happen to it. We don’t want to get too far away from the steak shape, though, or people won’t understand it’s still the steak.’ I tried to make a mold off an actual New York cut steak and found, to my amazement, that you can’t get the alginate material off the meat, because the muscle fibers stick to it. So that was one New York steak down the drain. I realized at that point that I had to sculpt a steak, which I made out of clay, molded and cast in foam. It was operated like a rod puppet — total simplicity.”

The “cancerous tissue” that Reardon injected into his steak from below was not meat, but a plastic compound molded into odd amorphous shapes. “The nice thing about it was that because it was mostly vinyl, it tended to spring apart from itself when no longer compressed, and crawl away a bit. I don’t believe real meat would have done that. Injecting it from below was a grease gun affair — quick and dirty, and effective.”

Along the way, Spielberg pointed out another scene to Reardon in which the associate parapsychologist sees something mind-snapping in the mirror after he’s already witnessed the

notorious steak. “The way the script described the scene, the character sees the steak do its number, and then sees the chicken leg swarming with maggots, which prompts him to reel over to a utility sink off the kitchen. He looks in the mirror and sees a corpse staring back at him, dressed in a burial suit. Mike McCracken suggested: ‘Wouldn’t it be interesting if instead of seeing a corpse right away, this guy *becomes* a corpse himself, on camera?’ I chuckled over the ghoulishness of the idea and phoned Kathy Kennedy, asking her to convey the proposition to Steven. On the return call, she confirmed that Steven had given it the green light, provided we make it look ‘as good as the stuff in *Alien*.’ Steven was so impressed with the effects in that film he would show certain reels to production team members to illustrate the kind of organic realism he wanted to achieve in both *Poltergeist* and *E.T.* — which he was going to do next. Anyway, with this new responsibility, Mike and I were *really* up to our necks in work.”

Reardon knew it was a matter of making a duplicate head of the actor, rather than a makeup job per se. “On the set, I showed Frank Marshall what I figured they should try to get with Marty Casella — the man playing the parapsychologist — which would lead up to the point where we would substitute the head. Unfortunately, burdened with work as I was, I couldn’t be there while they filmed it. However, we had already constructed the head at this point, so that was somewhat irrelevant. We hadn’t known in what posture to put Marty when we made a mold of his head, so we just secured an agonized expression and took our cast. It finally did intercut rather well with preceding footage of the real Marty, but I think the posture is a bit too erect all the same. In our brainstorming, Mike and I both wanted to see the face fall apart by itself, his flesh sloughing off the skull; and we also hoped we could show it moving, and changing expression, before and as this happened. I spent nights wondering how to rig the thing with attachments to facilitate expressions, and yet not expose these motivating devices when the face falls away. In fact, the night before the day of the shoot, I was up constantly, trying and then rejecting one thing after another, right up to the last moment. Our first attempt at the shot made a good impact in the dailies, but Steven requested a reshoot because portions of the face had come away in large pieces, giving the impression of removing a mask. Our second attempt incorporated a different sort of flesh’ which was a vulnerable gelatinous composition, and that did the trick. The understructure of the face — the muscle and bone — had been carefully sculpted by Mike, and it was revealed as the surface flesh fell away.”

During the take, a couple capabilities of Reardon’s head backfired. Originally, the eyes blinked and the mouth had more movement, but cables jammed. It was essentially operated as a hand puppet, with Reardon’s hand working it from below. “Though it was an important shot for the film, it finally fell into a little piece of time remaining at the end of one shooting day, which forced us to work more hurriedly than I would have preferred. We were all packed into this little laundry annex set — people and equipment — with the camera jammed almost up our rear ends. Mike McCracken was behind me, operating cables; I was in the middle, supporting the head with the aid of a C-stand rig; and Steven Spielberg was seated on an apple box right in front. It was his hands that would tear the face down to the bone. Steven had a little mirror angling upward — just outside the frame line — which he could use to show him where to grab at the face. Unfortunately I had nothing, and I had to go on what people told me from behind the camera as guidance in operating the head. They did have a video monitor, but its image was delivered from the actual taking camera and was dim to

the point of being useless. A lot of methylcellulose goo was pumped out of the head to simulate blood. I took quite a bath in all the blood and gore, and Steven was also drenched. Afterwards, he stood up into the shot and did a kind of comedy routine, feeding the thing part of its own face — which we all enjoyed in dailies. The flesh which falls into the basin was not the actual ‘flesh’ off the face, but rather a material allied to the material used for the cancerous steak. Tobe Hooper, with great amusement, dropped these fleshy pieces into the sink for the inserts, as he calmly smoked a cigar. The scene is gory. When we saw the unedited results in dailies the next day, Steven cried out in mock dismay, ‘I feel *cheap!*’ But he actually appreciated its impact, and intended to present it in the compact form seen in the final edit. Poor Tobe Hooper literally threw up. He later told me he’d only just finished off a huge Italian lunch and then walked in and watched this, and had to seek out a restroom in haste. I had to laugh. Here was Tobe Hooper — Mr. Chainsaw Massacre — and I had made him throw up. What an achievement!”

As principal photography wound down and the mechanical and makeup effects units began breathing easier, the cinemagicians at Industrial Light and Magic were just shifting into high gear. The first optical shot in *Poltergeist* shows billowing storm clouds rolling in over Cuesta Verde, taken from young Robbie Freeling’s treetop point of view. Remarkably, what appears to be a real suburban neighborhood combined with time-lapse cloud photography is actually a composite of paint injected into a water tank, a primary matte painting of the neighborhood, and a corrective peripheral matte painting of a cloud reaching off into the distance. “We used two sky plates from *Raiders* for the tornado sequence,” admitted Richard Edlund. “They were just right — very reminiscent of the ones John Fulton’s crew created for *The Ten Commandments* — so there wasn’t any point in reshooting them for *Poltergeist*. But the ones for the first POV shot were simulated using pigments in our tank. Gary Platek is a great technologist, and it was he who engineered the sky element. He and Garry Waller made up their own two-man camera team.”

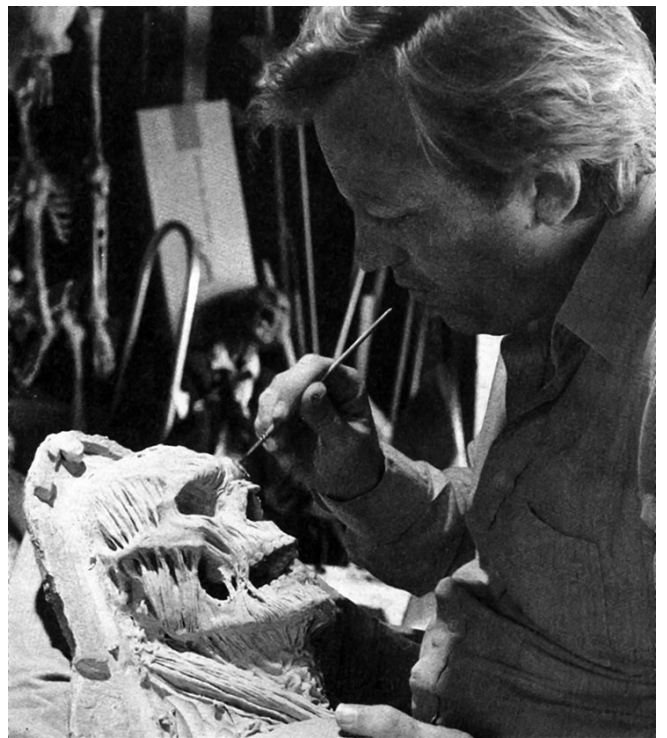
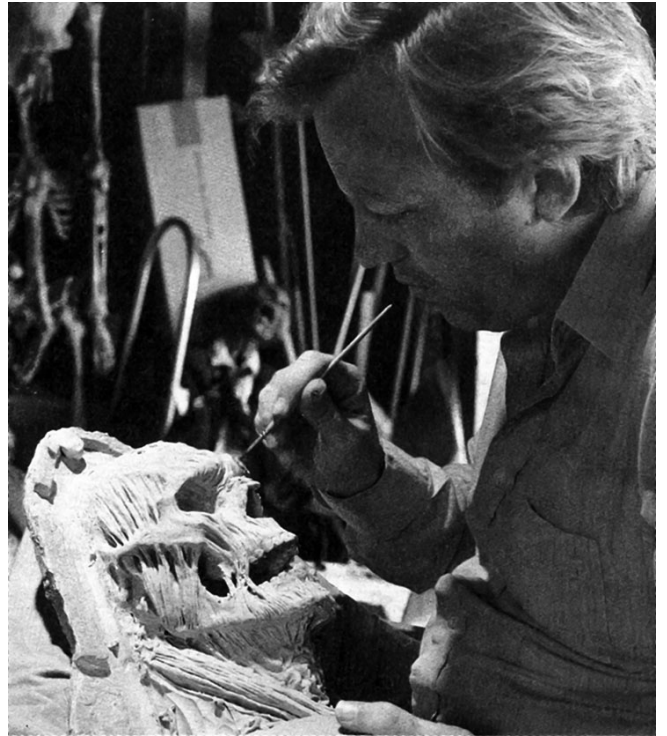
It was Platek who had created the turbulent skies for *Raiders* by injecting white Tempera paint into a large aquarium tank — seven feet square and four feet deep — containing a salt water inversion layer. In a darkened room, special probes painted black were used to coax the paint formations into specific shapes via a manually operated “atomic arm” — the kind used in handling radioactive isotopes. For *Poltergeist*, the same approach was repeated, with slight variations. “The technique was down,” Platek related. “So it was a lot easier this time. We originally had five cloud shots. Garry and I did all five in two weeks. The only difference was that we lit the clouds with colored gels on *Poltergeist*. We used orange and blue light for the sunset clouds, which turned out to be a little too heavy. It’s hard to light in the tank. In *Raiders*, we used white paint and blue light which gave it a more realistic look and made it easier to ‘grey it out’ in the optical printer. But we didn’t actually do a sunset coloration. We did in *Poltergeist*. For the first cloud approach, Mike Pangrazio did a lot of retouching. The cloud’s base line was actually painted in; and some of the *middle* of the cloud was painted in. The reason for that was when optical pulled the matte, it went clear in certain areas. The cloud painting also made the cloud plate and the primary matte painting blend better.”

Pangrazio, ILM’s resident matte painter, has sweetened many a shot since he first joined the Lucasfilm team on *The Empire Strikes Back*. The initial cloud shot was a striking case of skill and ingenuity. “The billowing cloud only went back so far in perspective,” he explained, “so I added the whole bottom of the cloud and its side. Obviously that part wasn’t moving. But in perspective, it’s so

far away toward the horizon that the top part of it moving was enough to sell the shot. In reality, that's probably what it would look like, anyway."

Matte photographer Neil Krepela doctored the shot into a healthy state, with a strong assist from the optical department. Krepela elected to bipack elements of the shot in the matte camera. "The clouds were shot in VistaVision on stage," he said, "and optical made us squeezed anamorphic prints of a holdout matte and a low-contrast positive print for bipacking. We shot the cloud plate and the painting on separate passes with the holdout of the clouds. Later, we loaded up the matte camera with the low-contrast positive, and exposed that image into the holdout area. Interestingly, Richard Edlund decided that it would be nice if we had a shadow on the hills as the cloud passed over it. I agreed with that. So Mike Pangrazio sculpted this little hillside to match a section of the painting and lined it up in the camera. When the clouds roll in, the shadow is there on the left side. I don't think anybody really sees it; but it's there, and I think it lends something to the shot and helps sell it as a real event. The final composite was honed by Dave Berry — described by Edlund as ILM's "resident optical printer artiste" — and cut into the film.

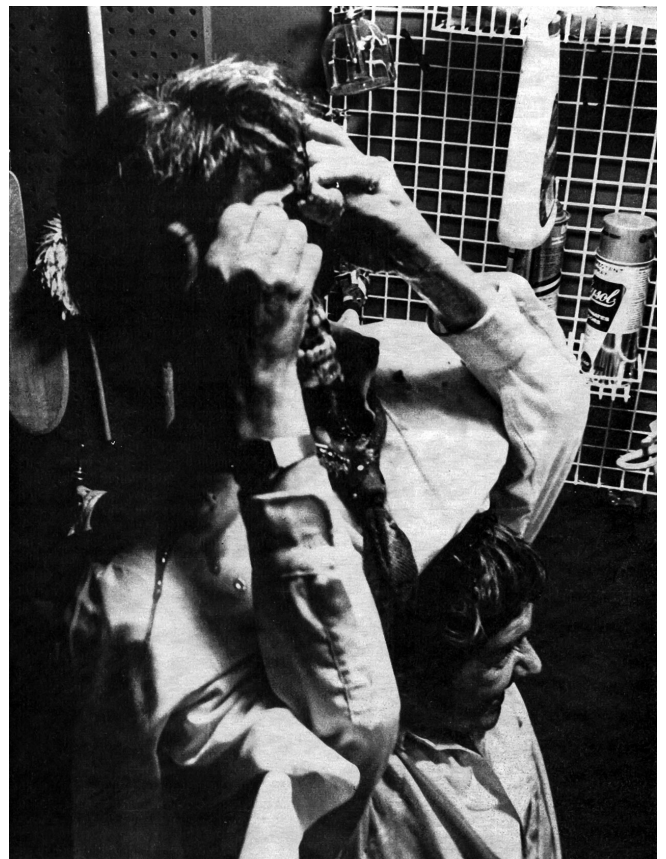
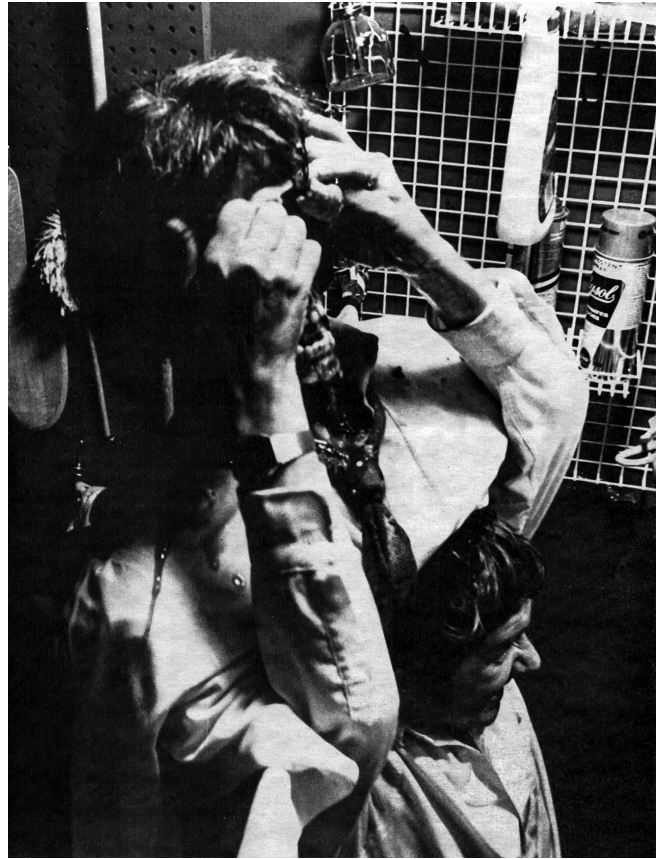
Mike Pangrazio contributed much to *Poltergeist*. Most of his work is perceived as existing images, as it ought to be. A sprawling shot of a hilltop cemetery, with live actors on one side of the frame, was in reality a matte shot. The live portions were projected from behind, and the cemetery was painted on glass in front with meticulous tonal blending. "The cemetery was difficult because the matte line went right down the middle of the frame," Pangrazio commented. "There was painted foreground, too. Whenever you have to match foreground elements, it gets hairy. So that was a real challenge. It took a long time to get grass textures. The plate had moving grass and the painting didn't, so obviously that was another problem. We had to scratch some holes in the glass for a grass effect, to try to get some movement in there. It wasn't very realistic, but it took the edge off the painting. We also pulled the camera back on that shot, which helped. Any kind of movement on a matte shot helps. To me, though, the shot was not totally convincing because of several factors. I thought the graveyard looked too busy, but that was something they wanted. You know, I could spend weeks doing wonderfully detailed gravestones with carved angels and things. Then Steven might say: 'I don't want graves in that area. Why don't we put in a pathway?' So you get burned sometimes, and you learn to be cautious. In this case, they kept emphasizing: 'Put more graves in there — more graves!' And it got so *busy*, it looked as though the left side had all the business and the right side had nothing. There were some good shots in *Poltergeist* in terms of not having the old 'castle-on-the-hill' type thing. When you're asked to paint out a real object from the scene and you do a good job of matching colors, no one will know it's a matte painting. There's some of those in *Poltergeist*, and they're good shots — because they serve a purpose."



For a jarring sequence in which the associate parapsychologist is transformed into a living corpse, a life mold of actor Martin Casella was taken, and then Mike McCracken carefully sculpted an understructure of bone and muscle.



Surface flesh was fabricated from a gelatin compound, and then peeled away during the shot.



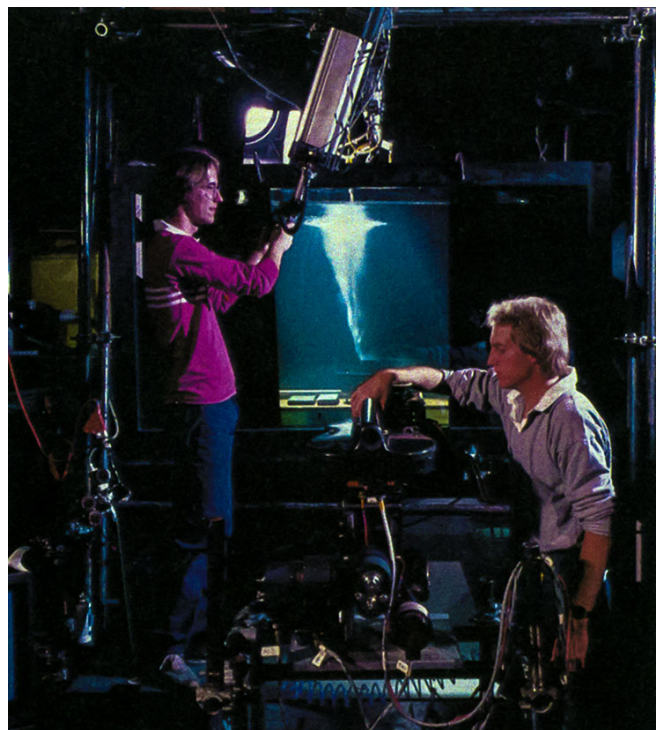
Crouched beneath the bogus head — and just out of camera range — Steven Spielberg himself did the actual tearing away of the gelatinous flesh.



Billowing storm clouds rolling in over Cuesta Verde were produced at ILM by injecting paint into a large aquarium containing a salt water inversion layer. Sunset coloration was attained during photography with colored gels on the key lights.



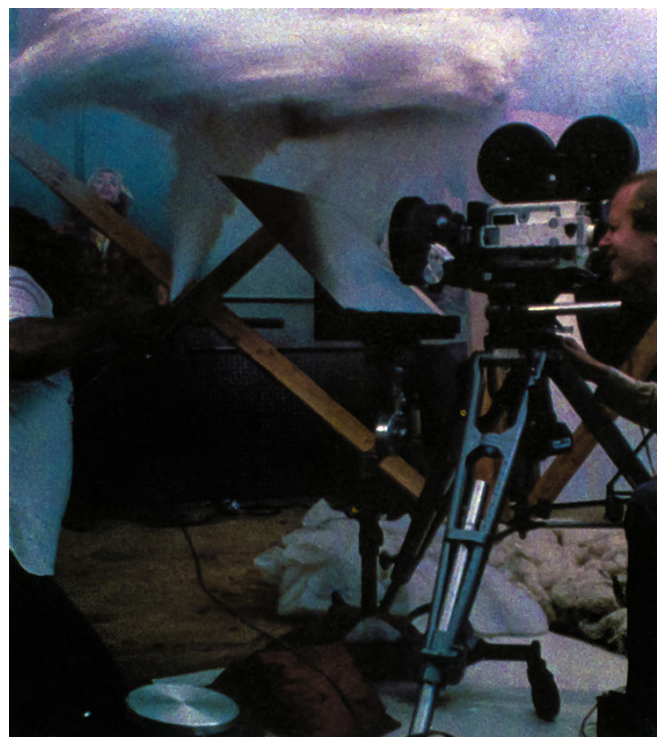
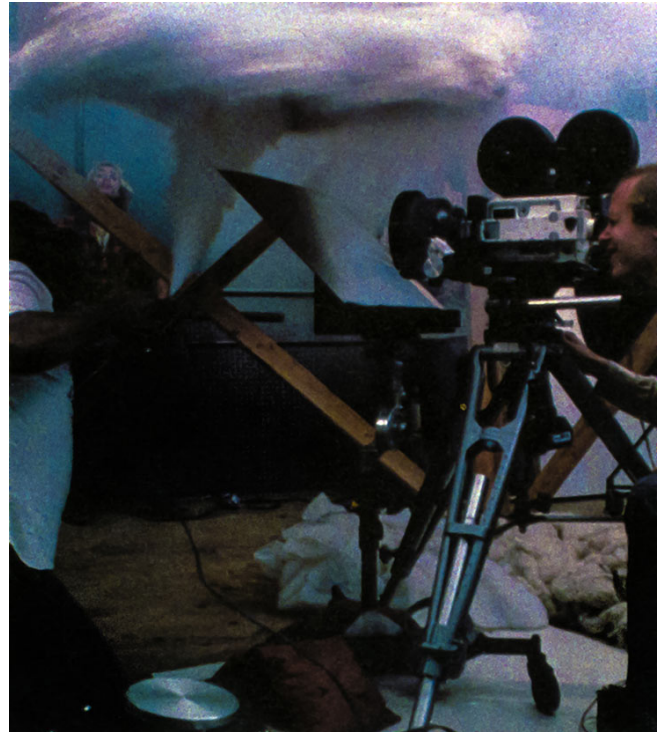
The ominous tree outside the children's bedroom. A total fabrication, this composite consists of a miniature tree, a cloud tank sky and cel animated lightning.



Gary Platek and Garry Waller photograph the tornado which rips through the neighborhood. Like the clouds, it was shot in a water tank, but with a high-speed impeller and a bubble generator to create an appropriate vortex effect.

In October 1981, ILM's tornado went before the camera, another tank effect executed by Gary Platek and company. Before going into production on it, Richard Edlund considered its filmic progenitors. "Of course, we talked about the famous *Wizard of Oz* sock shot. That tornado was actually an enormous sock driven across the bottom rear of the stage by a car. Then there was a gantry arrangement above for moving the top. It took almost the whole height of the Esther Williams stage, and it was spinning this horrible, asbestos-laden Fuller's earth all over the stage. For days, those poor guys — God knows where they are now — had to breathe that stuff! Arnold Gillespie did that scene. We found out that M-G-M spent \$50,000 doing their tornado; and we spent \$50,000 doing ours. But in those days, \$50,000 was enough to make a feature."

Edlund and Platek eschewed giant socks for miniature tank work. Succinctly, they created a vortex in the ILM tank and injected air bubbles into it, giving it a form that the optical department could massage into a gaseous, turbulent strain. "There were a few different ideas kicked around for the vortex," Platek explained. "What we finally decided upon was a rotor impeller that we placed in the bottom of the tank, with a drive shaft linkage that connected to a one-horsepower motor. Interestingly, there's a pulley you can stick in a beaker that stirs itself and is known to make a vortex. So we copied that and made our own vortex, which at full force measured about two feet high. It worked quite well. I found that if you just sucked air out of a tank, it looked like a water effect. It was too smooth and perfect, similar to the tiny vortex that forms when you pull the stopper out of a bathtub. So instead of merely sucking air down into the impeller, I took a Marineland bubble wand — a gimmick that generates hundreds of tiny bubbles via compressed air — and attached it to the 'atomic arm' by gluing it onto a piece of brass. The tornado was actually made of spinning bubbles — the water effervesced. As the impeller spun, the water spun in both directions. The air would stay in a cone shape, just about where you wanted it. If you spun the



For a later up-angle, stage hands Harold Cole and John McCleod coax a spinning cotton cone into proper formation. Cameraman Neil Krepela then photographed the interior by shooting into a mirror. The uprooted miniature tree was later inserted optically.

impeller fast enough, it would suck air down all the way to the bottom and make a triangular shape. We'd spin it a lot slower. You could control the speed of the impeller so the bubbles would just touch the top of it. Then you'd film it quickly before the bubbles hit the rotor and fogged up the whole tank. In order to make the tornado dissipate, I'd turn off the air from the bubble wand and lift it out of the water at the same time. I would try to whip it out and have it follow the path of the bubbles, so you wouldn't see the wand. But in one of our shots you can see it — it looks like a dancing telephone pole.”

The tornado tank was filmed in front of a black background in the manner of the cloud tank shots. Top-lighting was used to get uniformity, and side-lighting provided a shadow. “Unfortunately,” said Platek, “it looked flat in the end. In order to give it depth, they darkened it down. Dave Berry played with it on the optical printer. He did a few passes that grayed it down a bit, and they really looked nice. Beyond that I don't know what he did with it, since I left before the final compositing. For some reason it just went flat.”

Bruce Nicholson held a different opinion. “We were fairly happy with those shots. What we ended up with was certainly a vast improvement. When they shot the vortex in the tank, we pulled a photographic density matte from that and used a certain amount of diffusion in the process. I think it went a couple of generations from the original. So the bubbles dropped out with the diffusion and caused it all to blend. Ultimately, we ended up using just a black center matte with the background and a clear center matte just to put a little flash exposure into it. As it turned out, it's almost black. Animation augmented it with lightning flashes.”

Two major tornado shots were used in *Poltergeist*. The first and most complex had it advancing around the house, which required a camera move on the twister element. To do this, ILM's Empireflex high-speed camera was mounted on a motion control head riding a track. A program for forward, panning and tilting motions dictated the camera move. A video setup recorded and played back the shot, enabling the operator not only to scrutinize the move, but to check to see if the bubble probe was visible. The camera rolled at sixty frames per second during the latter half of the shot, and the move lasted five seconds. “It took fifty-six takes before we got one that we even liked!” said Gary Platek.

The full-size set for this shot was built at M-G-M. As the action progresses, the tornado skirts around background houses and trees to give it proximity. Mike Pangrazio did the entire background as a matte painting — trees gently move on the plate and pick up the lightning via animation. Finally, the reverse action of the shot had the tornado dissipate. Oddly, the plates for this one were shot on location in Simi Valley, which required careful matching of the “magic hour” evening lighting to the corresponding stage shot — and of course, meticulous balancing of the matte painting. The need to match an outdoor location shot to an indoor stage shot, with only a few brief cuts in between, derived from the fact that the script was still in flux when principal photography began. The location shot had been done on the second day of shooting, and by the time the sequence had been fully worked out, the camera crew had relocated to M-G-M. “Actually, it made no difference to us,” said Richard Edlund. “We were able to balance the shots anyway. Unfortunately, though, nobody sees our tornado dissipate because Dana's dress flips up in that shot, and that's all anybody looks at.”

“The location shot was actually done with a bright sky,” Pangrazio revealed. “Then they decided they wanted it to be dusk. I had to paint the sky down dark and time the plate in the composite to provide the appropriate light phenomena. I painted the swimming pool in there — it was just a dug-out hole — and I painted the fence, some neighborhood houses and a swing set. That worked out well. Nothing gives it away as a painting.” Optical added to the location shot immeasurably by having Dana Freeling run into Pangrazio’s painted pool area. Articulated roto mattes of her body were generated by Jack Mongovan, and the effect is entirely convincing. “For the *stage* shot of the tornado advance, I added a eucalyptus tree, the fence, the neighborhood, and painted out a *ladder* on the side of the set — *that* was a real challenge. In the Cuesta Verde overlook shot — a master shot — they shot the plate toward evening, but it wasn’t adequately dark. So again, we printed it down and I added the sky, some mountains, and put in some lights. I also sprayed some ‘haze’ in there and flashed the plate a bit to get it looking a little misty, as though it were night fog.”

The final tornado shot — an up-angle where the tree gets sucked into the vortex — was a separate entity altogether. In the tradition of M-G-M, a large sock fabricated out of gunny was rigged, with the camera shooting straight up into it. Neil Krepela photographed. A miniature tree was shot bluescreen motion control, and Dave Berry pulled the composite together.

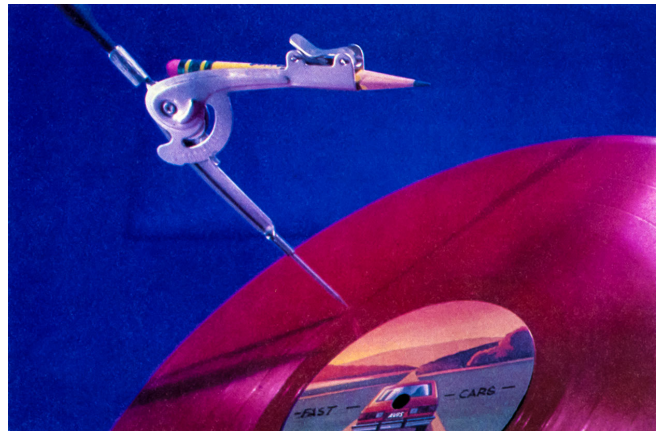
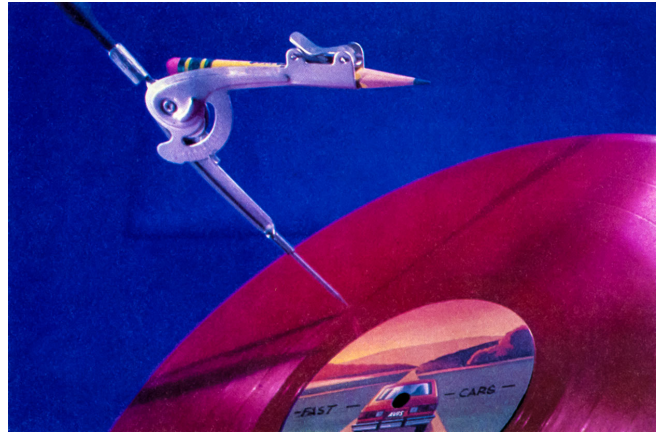
Obviously, the visual thrust of *Poltergeist* was the *poltergeist* manifestation itself. The movies have conjured up effective ghost images in the past — *The Haunting* and *The Uninvited* had their share, not to mention *Raiders of the Lost Ark*. But *Poltergeist* required a different-drummered apparition, one that could reach out like an appendage and divide in multiple swirls, fluidly. Cel animation seemed to be the only feasible technique, but Richard Edlund had certain misgivings about it. “It was necessary to find a really astute animator, because there was a certain amount of animation required that I was really trepidacious about. Animation and live-action are always hard to mix. Any animation that I’ve ever seen in a film — from *my* standpoint, doesn’t work. There’s a good example in *The Ten Commandments* with the Pillar of Fire. You remember it as really being great; but then when you go back on it, it *looks* like animation. It’s nearly impossible to make it really work. I asked a friend of mine working in Montreal to let me know if he came across a good animation director with a knowledge of special effects. He said I should definitely talk to John Bruno. While I was down in L.A. shooting plates, John called. I saw a reel he did for *Heavy Metal* — a really *good* animated film in terms of technique. We hired him. He then brought in animators that he knew — one from Korea, one from Yugoslavia. One guy may have been from Rumania. We ‘combed the world’ for talent.”



A Michael Pangrazio matte painting. Except for the upper right-hand portion of the frame — including the actors, a small section of fence and a few headstones — the entire shot was meticulously rendered on glass and then composited via rear projection.



The threatening books and other flying objects in the children's room — sometimes a dozen or more on screen at a time — were extremely labor-intensive, both from a photographic and an optical standpoint. Eight full months were required to fine-tune the two brief sequences.



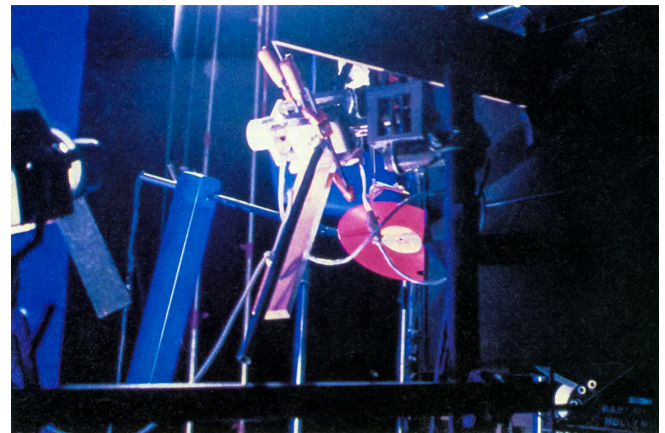
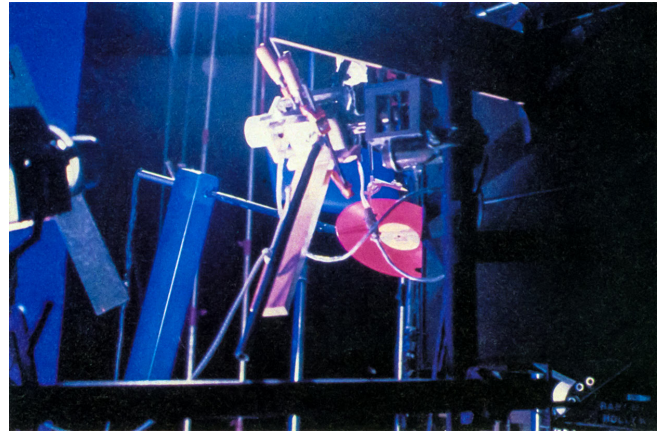
An isolated bluescreen element for one of the most striking of the flying images — a compass and a record which join together and spin through the scene.

“They were trying for something in *Poltergeist*,” said John Bruno, “that would be an extension of the ghost effects in *Raiders* — which were done with different cloth concepts in water, but they weren’t able to control that well. Richard asked me if I could design and do ghosts. Basically he wanted them to move dimensionally.” Bruno spent his first two months at ILM doing tests, and wasn’t officially hired until his experiments raised a few eyebrows. Edlund thought they looked promising. Spielberg referred to his ghost images as ectoplasm, and although the term was more suited for the jelly-like substance clinging to walls and bodies after an “attack,” it became a fixed euphemism for the *poltergeist*’s swirling presence. Bruno’s first test depicted ectoplasm surrounding a doorway. “Basically I figured the only way to pull this stuff off was to use light — different light passes — and not cels at all. But we got into a situation where we first had to animate ‘smoke shapes.’ I tried a number of tests, animating different densities of light. First, I did four or five passes of animating smoke on painted cels. I figured that if I could get four different tones within this light, at least it could have some dimension, and that maybe I could separate them and have them move at different rates. We tried all kinds of things.

Garry Waller shot footage of a glove filled with white paint, slowly sank it in the water tank, and tried to animate wisps by studying the footage. If that didn’t work, I figured I’d cover it up with lights and have a pulse go through it. Stills of this looked pretty fantastic. The next step was to find somebody to do ‘the perfect ink job.’ I contacted Auril Pebley, one of the effects animators on *Heavy Metal*, through Lee Dyer at Disney Studios. He said she was the last of the great inkers. As a test, I went to L.A. with a scene that I had drawn. She inked it and came up with different tonal wedges. Frank Marshall saw the test and accepted that concept.”

At that point, Bruno continued working on the ectoplasm for the hallway sequence, which would eventually manifest itself as *the Beast*. “We weren’t ready for the TV yet, but we were heading in that direction. I figured we’d be dealing with no less than ten passes through the camera at any one time; so I contacted Jim Keefer, my principal effects cameraman on *Heavy Metal*. Jim was the first person I officially hired for *Poltergeist*. He’s the only guy I’ve ever met who could do multiple passes and never make a mistake.”

Edlund and Bruno set up an animation department of roughly twenty people, most of them *Heavy Metal* alumni. Rounding them up was no easy chore. Milt Gray was in Korea, and Jose Abel was in Budapest working on a Moebius film. Bruno’s friend Art Vitello, a producer of Saturday morning



The motion control setup for the shot — photographed by Rick Fichter — was a complex maze of cables, stepper motors and blue pylons. Once completed, the element was but one of several composited together into a background plate of the children’s bedroom.

shows in Los Angeles, agreed to come up and animate. Terry Windell, Bruno's key layout man in Toronto, was hired on the spot as he and his wife were passing through on vacation. And Renee Holt, who set up the *Heavy Metal* shop in Los Angeles, was enticed into becoming an animation supervisor. She in turn brought up her own corps of animators.

In animating the first scene of the ectoplasm coming out from under the children's bedroom door, Bruno established a work scheme. The average frame took three to four hours to complete. One animator would do the basic 'smoke' shape; another would do the different inner cores of color; while yet another would animate the light pulses. Bruno and Keefer would then put light passes through it. "That was the original concept — not to make it have an animation-formula look to it. One experimental scene of the ecto hitting a doorknob in the hallway was sent down to Steven as a concept, and he accepted it. At that point, I got kind of nervous, because I didn't know quite how we'd done it! From then on, we were really into it."

Effects editor Conrad Buff worked closely with Richard Edlund, and contributed an astute visual sense to the film. Many scenes were saved by Buff doing imperceptible jump cuts here and there, and he added an evenness to the crew. On the animation, however, Bruce Nicholson had his own set of problems. "Steven was intent on using more animation for *Poltergeist* than we'd used for *Raiders*. There was a lot of trial and error. Essentially, the animation department came up with a look that was highly detailed. Steven wanted all of that desaturated, and much to our animators' chagrin, most of the detail was lost in the composite. I think it was for the better, though, because we got better blends and it looked more realistic. Some of it worked well; some of it still looked cartoony. It's particularly difficult when you're dealing with a specific lifeform."

If animation composites made the optical department uneasy, they were cream puffs compared to the sequence of flying objects in the kids' bedroom. Dealing with a real environment, one that people are accustomed to looking at, made everything problematic. It was a matter of reaching for the highest credibility level possible in a fantastic situation. There could be no cheating. "Frankly," said Edlund, "it was the most difficult bluescreen sequence we've ever done. The number of elements was extraordinary, and a foreground matted into somebody's bedroom had to look as though it were really there. You would either buy it or be painfully aware of artificiality. All matte lines had to be absent, which was asking for a small miracle. We also had the extreme problem of having this horribly bright closet on one side of the frame, and relative darkness on the other side. That sequence actually involves the first two motion control pans and tilts done with our field recorder. The room itself was a small bedroom, shot as a background plate with a 20mm lens. That lens gave us a lot of depth. The actors in the foreground had to be as sharp as the objects in the background. We were shooting at f/4 and couldn't carry too much depth of field. Besides that, Beatrice Straight had this red hair, and objects were going to be passing between her and the background plate. We had to deal with a sandwich. We shot the foreground with a pan, starting on Richard Lawson and ending on Beatrice. I think we got to know every strand of her hair! So the background was shot with a pan, and the foreground was shot with the same pan. The people were composited in optical with bluescreen foreground and at least ten objects flying around! All of which had to be matte-line free. And Bea Straight was against a bright doorway. That *had* to be matte-line free."

Bruce Nicholson probably felt the sting more than anyone. “The over-the-shoulder shot, where you see Dr. Lesh and her two assistants looking at the greatest quantity of flying objects, was honed up to the very last day that we were able to get material accepted for the picture! It was really taxing. There were times when I said, ‘It’s never gonna work.’ All the objects were shot bluescreen, individually — the toys, the compass, the books and whatnot. Since the background was bright in certain areas and medium tone in others, an object hitting an intensely bright area would suddenly become transparent — all of which was difficult to control. There was quite a lot of blurring to deal with, and not getting a noticeable matte edge on blurred objects was tough. So was color balancing. If one of the objects was off, we’d have to redo the whole shot.”

Camerawork for the sequence was divided between Rick Fichter and Bill Neil. A former aerospace designer and documentary cameraman, Neil met George Lucas in the Sixties and eventually migrated to ILM, where he helped design cameras with Richard Edlund. Bill Neil’s primary contribution to the flying objects sequence was the “magic book” that flies open and flaps its pages. Though his immediate instinct was to do it as a motion control element, Richard Edlund suggested instead that it be filmed as live-action due to the problem of trying to animate the flaps. “It was actually a combination of live-action and motion control,” said Neil. “I used the field recorder, which recorded a pan and tilt and allowed me to play it back in real time. I used that to actuate the camera. For the objects that were supposed to go around in a circle, I combined pans and tilts. With the field recorder on, I had the whole unit on a piece of track, and I would hand-push it back and forth to get the perspective changes. So the camera was automatically panning and tilting while I pushed it manually. I did that as fast as I could, while a fellow in back was flapping books.”

The books were shot high-speed. Some of them in the scene were simply on shafts that would spin, rigged with cables that went out the back. The pylons, of course, were neon-blue to match the screen. Using the cable system, the operator could push a handle to make it open and close. The larger book — a dictionary — was operated in a similar fashion, but done meticulously since it was a direct, and rather threatening, foreground element. For the flapping pages, a mechanism was developed by the model shop and rigged specifically for that shot. “It was a little hand-operated scissor deal with a neon pylon on it,” Edlund explained, “like the claws you pick books off a shelf with. The operator would crouch down and operate the tiny paddles, and then roto would garbage-matte him out of the shot, if necessary. Bill shot it kind of ‘winging’ it, knowing that his camera moves and pans were keeping the book ‘moving.’ Then Bruce had problems in getting good mattes from the books because the pages were blurring like mad.” Nicholson spent hours doing precise matte fits and softening the blurs with diffusion and smears of vaseline on glass in front of the printer.

While that went on in one corner of the stage, Rick Fichter programmed all the motion control work in another. “Richard and I discussed the sequence and decided that for the shots requiring more exact flight paths, bluescreen motion control would be the answer. Since Bill was operating the high-speed camera, I went on what we call the ‘Rama camera — an old three-strip Technicolor unit converted long ago to Technirama (like VistaVision, an eight-perf horizontal format) and mounted on a motion control tracking system. The actual scheduling of shots was left up to our production coordinator, Laurie Vermont. I’d just go into the office and say, ‘What’s next?’ She had all the

storyboards on the wall, and we'd pick shots accordingly. It also depended, of course, on what cameras were available, and what space was available. Laurie kept track of all that, too.

"We tried to start out on the easy stuff. The problem with the whole sequence was that nobody knew quite how things should fly. We started out with the records on pylons — shots that we found were generally easy to do. The main problem was getting the timing down on the flight paths so the objects wouldn't crisscross and obscure each other. There was a flying lamp that screwed into itself, a galloping horse, a compass that comes through the door and attacks them." Each item had unique problems but Fichter, a calm, methodical thinker, enjoyed solving them. "The trick to the lamp was timing the action to the plates that had been set up. The way the plates were shot more or less required the objects to hit a certain point within the frame at a precise moment."

Of all the flying objects, the record/compass combination is the most striking and memorable. No other image conveys such a peculiar, eccentric quality. Choreographed with finesse, the record spins into frame while the compass joins it somewhat sinisterly, digging its point into a groove before sailing off in unison. Although most of the flying artifacts were photographed separately, the record and compass had to be shot at the same time in order to eliminate any chance of misalignment or spotty lighting. "Plus we'd have to run all the mattes and holdouts," said Fichter, "and do the composite before we'd know whether the shot was successful or not. The threat of it not looking perfect would never have solved itself." The dual element was also a problem in that it had a tendency to get obscured by the other objects. "It was a bit of a tiger, getting that thing to work — to slip the sync on the editing of it and make it fit snugly into the scene. The compass and record were mounted on separate rigs, and we only had so many channels of movement. Most of them were keyed to the record: rotating, rolling, pitching. It was *always* rotating during the shot at a slow rate, so it could correspond to our photographic rate. We were limited to the number of axes we could move on the compass, though. It became a problem, trying to finagle the axes in just the perfect position for maximum movement and efficiency. The way it had to be done was to find the point within the shot at which the compass would touch down on the record. *From* that point, I had to program backward and forward, always keeping that point intact. It became a problem, because at the touchdown point, everything had to come to a dead stop. Having the flight path continue along a smooth arc took quite a bit of doing. The programming alone took several days. When Steven saw it in the dailies, he said: 'Jesus, I wish it was longer. I'd really like to play that image on the screen.' So we went back and did it *again*! This time, we were limited further because the other camera crews had borrowed some of the equipment. We had to put together a rig with C-clamps, clothes pins and chewing gum in order to make it work."

Poltergeist's potpourri of visual effects would not have been complete without a touch of stop-motion animation. Ken Ralston took a break from his supervisory position on *Star Trek II* and stop-framed a motion control bluescreen shot of an Incredible *Hulk* doll straddling a galloping horse. The bluescreen work for all the flying objects took ten weeks to film. Several shots contained twenty or more elements which had to be matted together. Bruce Nicholson and his crewmembers massaged the sequence optically for a record-breaking eight months.

Another major concern was the ghostly apparition that appears at the top of the stairs. The sequence went from stage to optical in January and February, but conceptual and photographic permutations of prior months resulted in a labored birth. "The original idea of the ghost was not a

beautiful female figure,” explained Nilo Rodis-Jamero, “but rather a nebulous ball with tentacles. The idea was that of an unfathomable beast with a string of lights attached to it, keeping it in check. It turned out that Steven didn’t really know what he wanted to do with this sequence. There were physical lighting effects representing ghosts — *good* ghosts that convey a sense of caution about the Evil Presence. So we started off with a chain of lights. Steven loves to call himself Mr. Light. Everything is light with him. However, after we storyboarded it, we noticed that it needed more recognizable imagery, more solidification.”

Earlier, Richard Edlund had been rooting for his own concept. “It was an idea I presented to Steven. I was thinking of making the apparition look like an A-bomb blast photo I once saw in a book. It was taken less than a millionth of a second after the blast, and it’s the most evil-looking thing I’ve ever seen. We didn’t use that idea, although I think it would’ve been pretty good. But we got into a philosophical area while we were doing *Poltergeist*, in that certain sequences started happening with certain intensities. We had to modify those intensities to suit the picture; and we had to do that as the film was being edited. So we changed the idea around, making the apparition beautiful, feminine and stately.”



A shimmering ghost image appears at the top of the stairs.

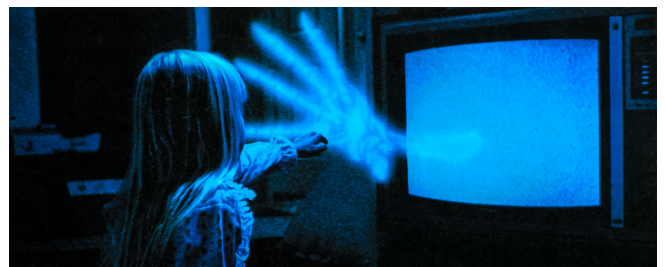
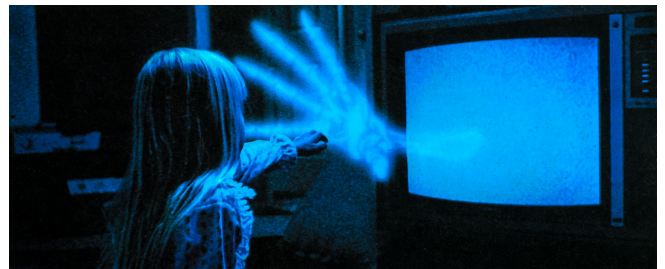


Effects supervisor Richard Edlund discusses the sequence with actress Paula Paulson.



Dressed in a streaming gown, and with a fabric mask to render her featureless, Paulson was placed in a flying harness and “flown” against a black backdrop. Filmed in 16mm at high-speed — thus requiring huge amounts of light — the imagery was subsequently doctored in the optical and animation departments, and then laid in over the live-action stairway plate.

John Bruno was involved in the basic design. “Steven wanted me to come up with some illustrations, so Nilo and I discussed it with Richard. I designed a ghost with a lot of trimming — gossamer strips floating around. Nilo made pencil drawings. We sent those down and Steven just jumped. He loved it. It retained the concept of the two ‘headlights’ in front of the ghost, with ectoplasmic arms — sort of like those little lights cruising around the mothership in *Close Encounters*. Richard decided to shoot a live woman and use her as a roto image to see how far we could go with it, mainly because our deadline was running short.”



Ultimately, the ghost looked almost Victorian — ethereal and graceful, yet threatening. The original

element was an actress dressed in white, flying on a harness against a black background, and composited into the live-action plate with a lot of animated lights and diffusion techniques. “I decided to try it with a 16mm Action-Master that can operate at five hundred frames per second,” Edlund elaborated. “I

felt that 16mm would be cheap and fast, and we could save some money. We hired Paula Paulson, a girl who played Peter Pan and was an expert on wires. We dressed her in a silken gown and rigged her in a harness. She was on wires for hours. She loves wire work. When she flew down, we cheated reality to an angle so it looked as though she were coming down the stairs in an arc. She would do certain moves which were orchestrated, and the result was an illusion that she was coming down straight, compensating for the angles. We blew the 16mm footage up to VistaVision inter-positive on a C-clamp printer. That alone resulted in kind of a fuzzy image — which we wanted — and then Bruce did some more massaging to get the ghostly quality. It took about two weeks on wires, one of the later sequences to be shot. We used hundreds of thousands of watts of light. Paula’s performance was choreographed so we could print it in reverse. Sometimes that works. The shot of the clown doll wrapping itself around Robbie was printed in reverse. We did several shots in *Raiders* in reverse. They did it in *The Ten Commandments* with the walls of water — now *there’s* a great shot! Ultimately, the visual ambience has to be developed in optical. When she disappears up through the ceiling, John Bruno came in with some animation that propelled the illusion Bruce and I had honed in the optical room.”

“One of the problems in shooting Paula,” John Bruno added, “was that the camera was running sixteen times normal speed. The ghost image at the end had to spiral up into the ceiling. To do that in real life, she’d have to be spinning at a thousand rpm’s! Even if it were possible, undoubtedly she’d pass out. So I wound up animating that, starting from the live-action and dissolving into the spiraling animation. Steven accepted it as it was, although I still had to put ectoplasmic tails on it. We did twice as many ghost scenes as those that appeared in the final cut.” Animation cameraman James Keefer assisted Bruno in animating all the flaring light images. All were done as separate passes in-camera, ranging from fifteen to fifty seconds each.

“Shooting in 16mm and blowing up to VistaVision caused all kinds of grain problems,” explained Bruce Nicholson. “We had to diffuse it like crazy. When you see the ghost on the top of the stairs, there’s a light behind it. We dodged that area a bit to cut down on the intensity. But the ghost was also *matted*. So we had this weird setup on the printer where we had the matte on the rear head with heavy diffusion next to the aerial lens; the background was in the front head with some neutral density in the area where the light was coming from behind, at the top of the stairs. Plus there were lots of articulated roto mattes on the stairway so the ghost would appear to come from behind the door. In certain cases, the arms would go behind the railing. There was ectoplasm in there with light animation. Some of the lights the ghost was supposed to go behind also required roto mattes. And with the ghost matted in, it was extremely complex. We didn’t want it so well defined. The exciting part for us was when you see the arm come out and the ghost comes up and you see part of the face above the doorway. Which was a neat moment, because it finally revealed *something*.”

Although the initial plan for the film was to use a 16mm camera, the final result was a VistaVision inter-positive on a C-clamp printer. That alone resulted in kind of a fuzzy image — which we wanted — and then Bruce did some more massaging to get the ghostly quality. It took about two weeks on wires, one of the later sequences to be shot. We used hundreds of thousands of watts of light. Paula’s performance was choreographed so we could print it in reverse. Sometimes that works. The shot of the clown doll wrapping itself around Robbie was printed in reverse. We did several shots in *Raiders* in reverse. They did it in *The Ten Commandments* with the walls of water — now *there’s* a great shot! Ultimately, the visual ambience has to be developed in optical. When she disappears up through the ceiling, John Bruno came in with some animation that propelled the illusion Bruce and I had honed in the optical room.”

Also during the living room manifestation, a swarm of glowing images appear on a TV monitor — images barely discernible, yet eerily recognizable. The apparitions were shot live on the set — which was draped entirely in black — using lights mounted on the ghostly actors' chests. The shots — done in 35mm — were then massaged and modified by Pat O'Neill, a master optical printer who runs a small company called Lookout Mountain Films. "You saw someone in a Panama hat," Richard Edlund observed, "something in period costuming, blazing light patterns. You saw it, but you didn't. It was that kind of thing."

Once the images dissipate and the female ghost funnels upward, the bilocation point is discovered — a dichotomous portal in the ceiling through which the characters re-enter the real world after having passed through the closet accessway. Once the film shifts gears, the bilocation becomes a central story point, and a hair-puller for the optical department. Two basic sequences revolved around it — the jewelry and the tennis balls falling through, and the womb-like "rebirth" of mother and daughter as they break through a membrane, returning to the here and now.

"Throughout the production," said Mitch Suskin, "we were never sure about the shot where Diane and Carol Anne come through the ceiling. Originally, it was supposed to be much more elaborate than the final effect. Just below the bilocation point, you were going to see a 'birth sack' materialize with them inside of it. The sack was going to break and goop would start splashing down. Then they'd fall through. The final version was faster and much more to the point, which was wise. We weren't sure if it was going to be a stage effect or an optical effect with a miniature of the two girls — or a combination of both. In fact, we played ping-pong with that, right up to the day we shot the thing on stage. We even talked about having a blue screen suspended on the ceiling; we talked about building an entire room in miniature. Fortunately the effect was cut down to where it made more sense."

Much of this fell into the lap of model shop chief Lorne Peterson, who had to develop a system of lining the membrane — seen ever so briefly — with a gloppy substance, presumably a kind of netherworld ectoplasm. "Barrels of goop were sent up to us from Hollywood," he explained, "It was a foamy methylcellulose substance. The problem was, we had to find a way of *exploding* it as they punctured the membrane. I went to a surgical supply store to buy some tubing for a variety of other things in the show. The owner said he was out of it. He said kids were coming in and buying it all the time, filling it with water and wrapping these 'plastic sausages' around their bodies. Since it's always under pressure, it was the perfect giant squirt gun, with an almost unending water supply. Sure enough, as I traveled around, I began to see kids with 'body sausages' about five to six feet around. It occurred to me then that this would be a hot way of making an explosive goop device."

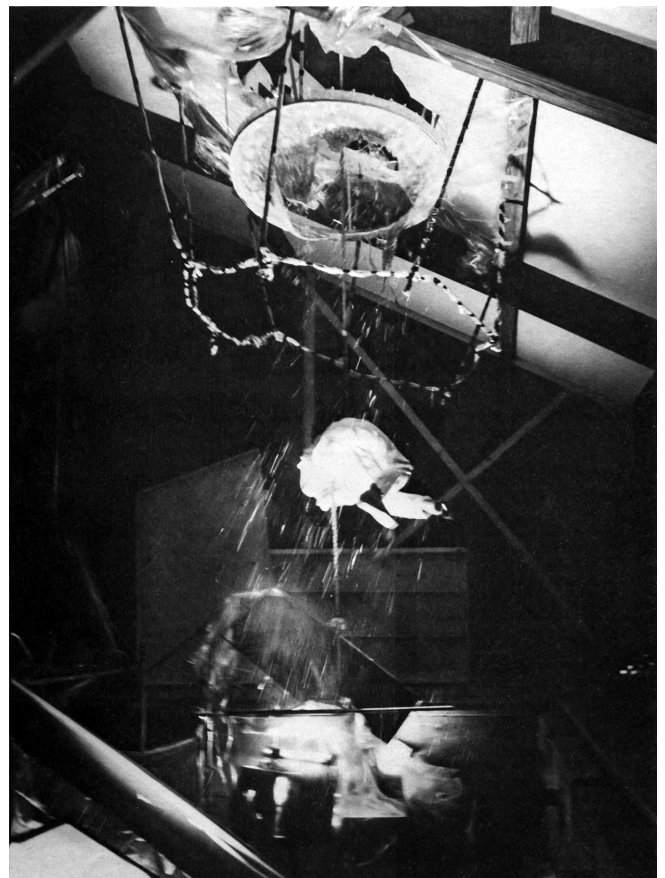
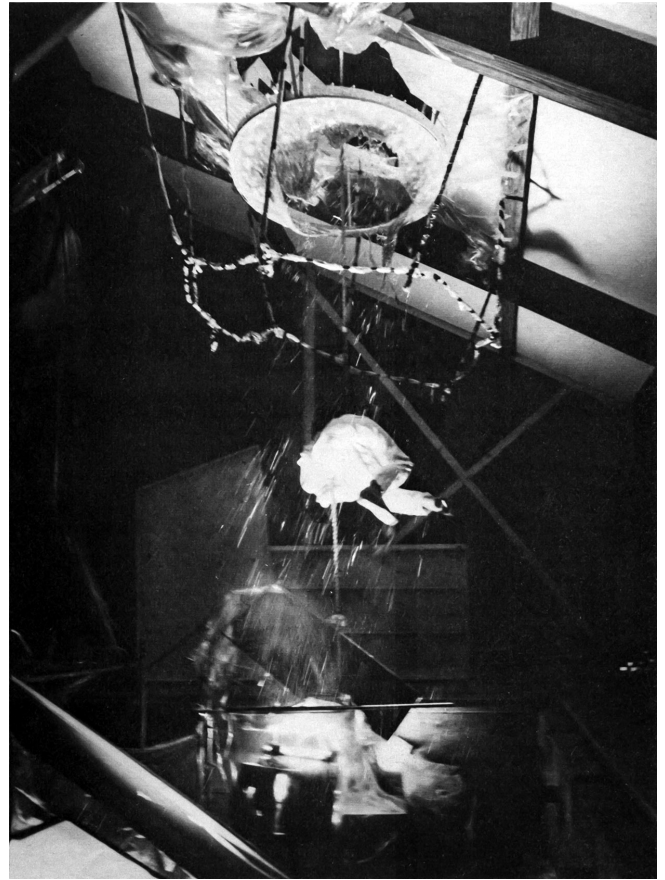
Peterson and crew put the goop in a pressure pot to get it inside the tubing. Six-foot loops of it were placed around the edge of the membrane, tied delicately, then rigged with solenoids and razor blades that would perforate it at certain spots. "The surgical tubing has the characteristic of turning a pinhole into a parallel slit, sort of like the run in a nylon stocking. And the explosion happens 'inward.' We did a lot of experiments with polyethylene and silicones for the membrane. Marc Thorpe used different silicones on a super-thin polyethylene stretched over a drumhead, and came up with a material that was clear at the vertex and got denser toward the edge."

Bill Neil was cameraman on the climactic drop-through. “The original idea,” he recalled, “was to do it with a live stunt lady. Everyone here was really down on that because of the accelerated rate of fall. To me it seemed dangerous to attempt. So I set up a manikin and did a test. It looked pretty good, so we got some better dummies for the mother and the little girl. The model shop sculpted them out of foam.”

“The stage was a zoo!” said stage foreman Patrick Fitzsimmons. “As the dummy fell, it tripped a number of different wires, effects and goop rings. There was a lot of flashing and strobe that couldn’t be coordinated. Having guys on a nailboard didn’t work out, so we ended up using a lot of trip wires — wires coming off the dummy’s main guide wire. All the different solenoids for the bilocation substances were all triggered off of it. We shot that scene on our main stage, and the stage crew built the set, lit it and devised all the camera positions for the extreme up-angle.”

Having the smaller objects fall through the point was achieved with a conventional split-screen. The tennis balls, for example, were dropped through a slit in the ceiling. In the editing room, jump-cuts were made, catching the balls in mid-flight. To get rid of the upper rigging, additional plates were shot with a clear piece of ceiling in the same camera position. Then it was a matter of matting the fresh ceiling into the action plates. “That wasn’t as easy as you might think,” said Bruce Nicholson. “There were a lot of strobes going on in the ceiling and in the room, and we had to match the lighting patterns. Getting rid of that bilocation slit was a small nightmare! We had to vaseline the matte line and do all sorts of things just to hide it. It was too hard for roto to articulate such a small ‘bald’ area as that, and the lighting caused a major problem in that regard. We *did* have an articulate matte made of the area so we could vaseline it, soften it up. I spent a lot of time on that at the very beginning of *Poltergeist*, because it was one of the first things that made me say: ‘Uh, oh.’ Even so, I never could get it *completely* removed. It ended up looking like a flaw in the ceiling rather than a hole. Fortunately, Richard took the time to shoot some additional plates from the same camera position where the strobe lighting matched.” For the jewelry popping through the ceiling, the pieces were rigged with monofilament from above. Some of them were composited optically as separate elements. In most of the bilocation scenes, an out-of-this-world flash effect was required — something unrecognizable to the layman, an effect that would result in light *shapes* in the midst of blaring stage lights and strobes. *Shock waves*.

“I didn’t want to do *shock waves* in animation,” Richard Edlund explained, “because there’s a stiffness to animation that never seems to transcend itself. At first, I thought of smoke. Then Gary Platek came up with the laser scan. We had done a bit of research on that for *Raiders* and it whetted our appetites. Gary, being a laser jockey, was only too happy to get into it. There were three phases to the laser business. One was the bilocation flashes that happened along the ceiling — the bluish stuff in the angry spot reacting to the violation of the rope and tennis balls. Then we had the *shock waves* at the end, by the imploding house, which were done with a *shaped* laser as opposed to the flat plane effect that Gary used for the ectoplasm shots. The other business was in the room when Tangina throws the tennis balls through the closet entrance point and the wrath of *the Beast* is upon us. Beyond that, there were little plasmic shapes of light that were done by Gary, laid in ever so excellently by Bruce with fabulous roto mattes from the animation department. There were dozens of those shots, backed by an enormous budget. It was so costly to do, and it’s barely there. Many people probably don’t even notice it, but it really contributes to the ambience. When we first talked about these scenes, Steven’s initial reaction was to keep adding more light. But since a theater screen can only deliver twelve foot-candles, maximum, there’s a point at which adding more light does nothing at all. With the laser technique, we were able to add light *shapes* that were both emphatic and disturbing.”

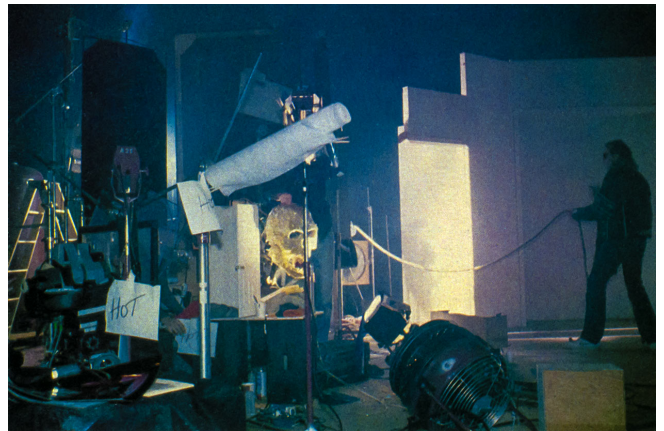
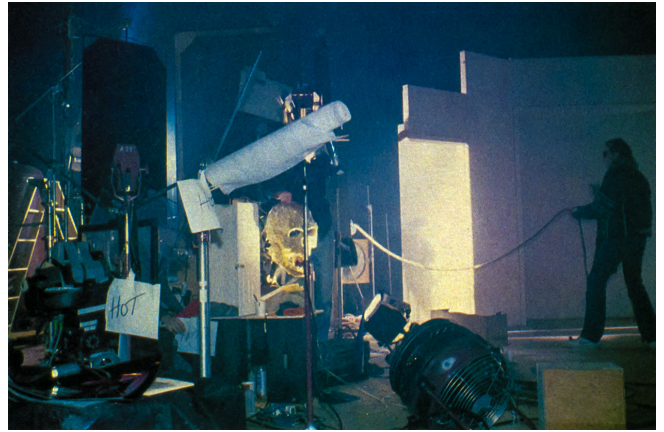


For the scene in which Diane Freeling and Carol Anne burst through the living room bilocation point, the ceiling

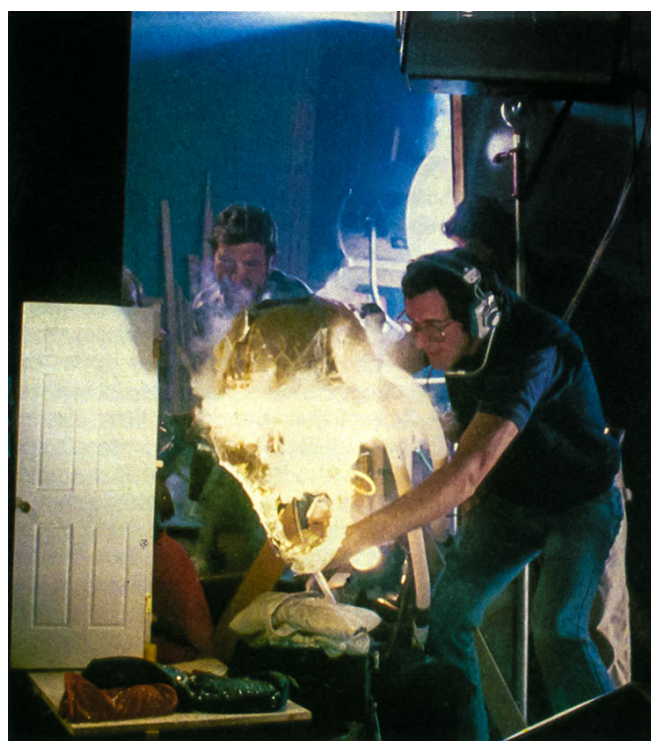
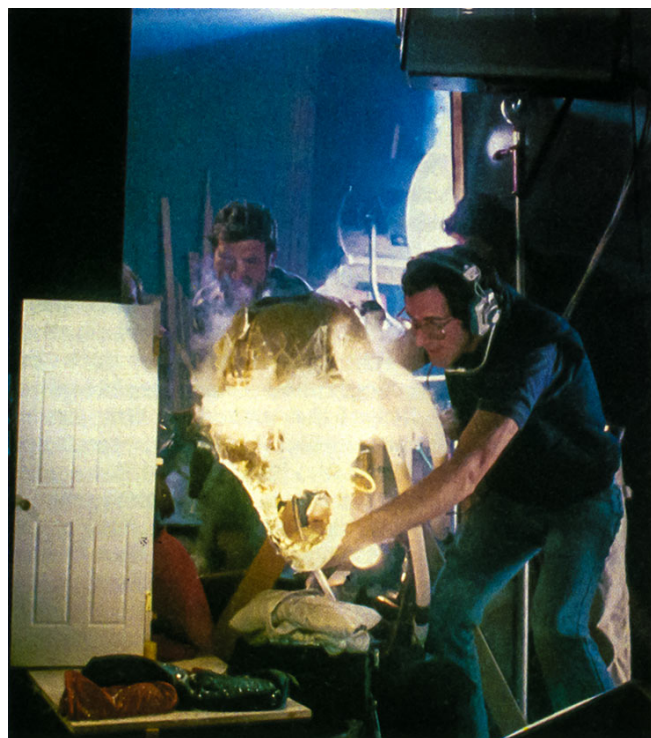
set was recreated on the ILM soundstage, with a circular opening built into it and covered by a thin membrane. Two dummies were tied to a rope and suspended above the hole on a system of pulleys. When the rope, which extended down to the floor, was yanked from below, the dummies dropped through the membrane, followed by streams of ectoplasmic jelly — dubbed “polterglop” by the stage crew. Animation and laser effects were later added to enhance the scene.



A giant beast head lunges through the closet door at Steve Freeling.



The shot was done as a stage effect by means of a forced perspective setup devised by Richard Edlund. The camera was positioned at the far left — close to a miniature door and an oversize leering skull. Then, several feet back, a full-size door frame was carefully aligned so that when photographed with a custom deep-focus lens, it would appear to blend in with the foreground miniature. Thus, actor Craig T. Nelson could pull on his rope and appear to be menaced by the seemingly gigantic beast.



Modelmaker Paul Huston, who constructed the track-mounted head, also operated it during the shot.

Gary Platek's laser scanning system was a thing unto itself. Using various gases, from nitrogen to CO₂ to freon, Platek would line up his laser effects to filmclips and shoot them in the proper positions for optical compositing. Mattes were generated right from the laser footage which was shot against black. The results — sharply delineated light shapes, at times defying description.

“Richard approached me and asked what I could do,” said Platek. “I asked him to give me a couple of days. I had some laser machines at home and brought one into the shop. On the first day of experimentation, I tried something simple and it worked well. With the laser beam, I made a tube of light. Originally that was done like a periscope arrangement, with the laser bouncing off a succession of mirrors. Since the tube/mirror rig was motorized, it would spin and blur the beam. If you put anything into that beam, it would be delineated. If you put dry ice in the beam’s path, only a slice of the ice would show up because the laser beam would not be visible anywhere else. The first test we did was with a fire extinguisher. I set up a camera and pumped the extinguisher, and the CO2 went shooting down the tube. The image we got was fantastic.

“At that same point in time, Gary Leo and I were working on a project of our own, a little laser-scanning machine — which is just a pair of x-and-y galvanometers with little mirrors on it, connected to an Apple computer. On the graphics pad, I could draw any shape and the laser would trace it out. So we could animate on it, up to about five hundred frames. For the *shock waves* in the closet, we used that machine with a four-watt argon laser. We would aim the scanning unit — the mirror that deflects the beam — right at the camera lens, and set up some black cloth around it. Then I’d take liquid nitrogen and shoot it down toward the camera. We’d film it anywhere from three to twelve frames per second. Richard would pick what he felt was best for a specific scene, to match its perspective.”

Bill Neil had his own alternate idea for the final shock wave where the realtor gets zapped moments before the house implodes. Laser techniques obviated further experimentation; but his idea was interesting, nonetheless. “What I came up with was basically a large smoke-ring generator, which could shoot smoke-rings up to forty feet. When you shot it at the camera, it had a bizarre quality. If you took the same scene with different magnifications through the smoke-ring, it would be like a circular heat wave displacing the image. It worked straight on or at a slight angle.”

Final compositing on all the laser-generated effects naturally went to Bruce Nicholson, who blended them into appropriate environments. “Once they achieved the images they wanted, the shots came to us. Among other things, we changed the colors on them to match the ambience of the room. For the effect at the bilocation point in the living room, we made separations. The original laser elements were very cyan — sort of an intense blue-green. We made them go white with a bluish cast — which the room was — and just doubled them in. The other *shock waves*, which occur from the point of view outside the house — coming through the window — were also separated out. I made them a yellow so they would match the lighting of the window. They were all the same blue laser light when they were shot. We simply manipulated the color to get a good match with the plates.”

Poltergeist had its share of production quirks, though none as peculiar as the Head in the Closet shot. Essentially a throwaway scene done strictly for shocks, the quick look at the Evil Presence was, strangely enough, one of Spielberg’s earliest filmic considerations. “Steven’s concept for the head,” revealed Craig Reardon, to whom the assignment was given, “was something like ‘Mr. Sardonicus’ — that name was even mentioned a few times — what with a face sporting an enormous, humorless macabre grin. Steven wanted it to look pale, slightly blue and bloodless, ‘like a face underwater’ — dead but not decayed. In the film, it was supposed to emerge from the closet in a blaze of light —

not discernible at first in the brilliance, but when seen, immediately terrifying so as to scare hell out of the audience; then just as soon retreat back into the light. It was discussed that we would see the head ‘head-on,’ so to speak, and so I designed it to be seen that way.” Reardon’s finished head had the capability of knitting and raising its eyebrows, and opening and rolling its pale orange eyes. “The smile would pull way back and the upper lip would pull away from the gums. The mouth — which opened very wide in a kind of Lon Chaney ‘*Phantom of the Opera*’ leer — was made with translucent backing so that brilliant light could be directed out through it.”

Reardon completed the head in July 1981, and it was shipped to ILM for photography. Although it had been Reardon’s assumption that the shot would be done via bluescreen to afford the greatest flexibility in compositing, the decision was made instead to do an in-camera composite. The camera itself was positioned directly in front of a full-size breakaway door, while the head was mounted on tracks off to the side at a 45-degree angle. A beam-splitter served to superimpose the two images in such a way that on film the advancing head appeared to fill the closet doorway.

“It was a terribly complicated shot,” Rick Fichter recalled, “and it *would* have been simpler in a lot of ways to have done it bluescreen. At one point we *did* consider doing the shot as two separate elements — where the head would be shot bluescreen, or against black for a density matte. However, it was felt that by doing it with a split beam, we could facilitate a more exact fit of the head breaking through, making it more realistic. Also, we could review the shot instantaneously on a TV monitor. We could have used a miniature door, but a full-size one was chosen because we felt it wouldn’t be possible to get the necessary look out of a miniature door breaking apart. The particles would not be in scale. At one point, we even entertained the thought of building a life-size head, but it would’ve been insane trying to time everything on that scale.” Fichter questioned the beamsplitter idea at the start because of the complexities of staging everything on cue, but saw certain advantages that a matting situation might have precluded. “For one thing, we were able to introduce atmosphere. It helped to have everything happening simultaneously so we could fog out the image of the head ever so slightly for the appropriate light phenomena, matching it to the distant doorway. Our optical department is especially good at matching mattes and diffusing them. But the amount of optical trickery, complicated by the light streaming out of the doorway, would have had us shooting it many times just to get the levels correct. Instead, we went about it very methodically by putting it all on one piece of film so the net effect could be seen the next day.” Rick Fichter used the motion control field recorder for the shot. “We had a lot of items on DC servo mechanisms, and so many cues on headsets, it was unbelievable! The cues came so fast because of the nature of the shot. We had to put some things on motors so we could get some repeatability for different takes. In this case, we put the camera on the field recorder head and the *Beast* head on a DC servo carriage. That ultimately worked out fine.”

In order to make Craig Reardon’s spectral head work visually in an in-camera situation, self-matting curtains had to be rigged just off the angle of the head in order to create the illusion of appearance and disappearance behind the door frame. Velvet curtains were elasticized by Peter Stolz of the stage crew, who also rigged the head. As the head crashed “through” the door, the miniature curtains would obscure the image at points that would conform to shadow areas in a full-size setting. Since the head was reflected in, the dark areas blended more naturally than they would have with a traveling matte. Compositionally, the head was situated by reflection in the center of

the frame, and actor Craig T. Nelson was a bit off to the right. The rest of the frame was filled in with a combination of deep shadow areas and blasts of light.

Fat Fitzsimmons directed the breaking of the full-size balsa wood and pine door, under the supervision of senior floor manager Ted Moehnke. “*The wood was scored where we wanted it to break. We did it with weights, and actually tripped the door by a solenoid implanted in the wood. A microswitch tripped the solenoid and pulled a pin, which allowed three hundred and fifty pounds to drop about four feet. Each wire for the door had to be run through a series of pulleys back to the main cable feeds at different lengths. One had to go two feet; another, six inches; and another, three inches. It was a trial-and-error situation, getting the cables to line up correctly. The facing of the wall was made of foam core covered with Durham plaster; so when it broke, it didn’t just fold up. It looked like crumbling sheetrock. We tested six doors and wound up shooting twelve. Twelve complete sets! An entire twelve-by-eight foot set had to be replaced with fresh wall and an entirely fresh rig. It was quite a deal.*”

Craig Reardon’s Sardonius-head shot took three weeks of prep work and photography, and the full cut lasted about four seconds. Reardon was not present during the shoot, as he had by then been enlisted to work on *E. T.* But when he returned to

ILM shortly thereafter, he discovered that his head, and the entire shot concept, had been scrapped. During his absence, Spielberg’s notion of the head’s appearance and the overall staging of the shot had undergone a radical change, and ILM was ordered to redo it to new specifications.

“Sometimes Steven had to make hard and fast decisions,” Richard Edlund explained. “Craig had done a wonderful job on the head; but suddenly, it became apparent that it looked too human. Steven wanted it to be scary. But in that original shot, you were looking straight into the doorway and no matter what you did, you were going to telegraph the punchline — because you saw it coming. As a result, the shot softened whatever scariness a closeup would have offered.”

Scrapping the closet shot in August knocked it off the effects roster until the following February. By then, optical was jammed with shots and the budget was getting depleted. Richard Edlund needed an alternative that was effective and quick, one that could be done in-camera — this time out of necessity. While Nilo Rodis redesigned the head, Edlund devised a clever alternative to the beam splitter setup, keeping it as a stage effect. Earlier, when Spielberg had introduced the idea of a full-size closet head, Edlund at first suggested that the shot be done using a foreground miniature door in a forced perspective situation. The idea particularly suited the new cutting angle, which put *the Beast* in profile on the left-hand side of the frame. A quick video test was shot, and Spielberg approved the concept. According to the scheme, the foreground miniature door frame — fifteen inches high — was placed in front of the camera lens. A short distance behind that, the new *Beast* would rear its ugly head. Completing the sandwich was a full-size door piece in the very rear that lined up in perspective with the foreground miniature. About ten feet back from the oversize head, Craig T. Nelson was situated pulling a rope which presumably extended into the closet. Critical to the success of the shot was a custom tilting lens Richard Edlund had developed for *The Empire Strikes Back*, which would carry depth of field from five inches to twenty feet at f/8.

Modelmaker Paul Huston built the new head. “Nilo and I spent a couple of hours drawing head concepts. Steven liked one of them, and I started sculpting this large skull with a bunch of rotting

flesh on it to match the rest of the graveyard material. I also made a rig on a track that I could wheel forward and back, keeping it in a really predictable position. It could go in and out from 'behind' the door from the same position every time, so we wouldn't have a focus problem on different takes. My first idea was to make it so you could move one item and everything would happen. But that proved inflexible. Every time we changed the camera position or the foreground door position, it required elaborate adjustments. So I ended up doing it all by hand, using the track as a guide while holding the head and the jaw. It gave me a lot more flexibility. The head had one simple neck joint, to seemingly drop down and lunge at Craig. I left part of it open in the back, exposing the plywood armature, and put an I-bolt there just to grab hold of it like a handle. CO2 smoke came out of the eyes. Small light bulbs were also in the eyes, and lit up as the gas pumped through. I had about two feet to move it on a track, and I had to wing this thing forward and hit a stop line while lurching the head down. The whole shot happened so fast that unless I opened the jaw at the right time, it didn't look like anything happened! So the timing was crucial; but with that kind of system, you could do eight takes with no sweat. I think we practiced with Craig Nelson about three or four times, and then shot it four times."



An earlier concept for the beast head was sculpted and built by Craig Reardon.



A test with the head was shot using a beam splitter which was aligned with the track-mounted head — invisible in the darkness to the right — so that the leering image would be superimposed into the full-size door set which was constructed with cables and weights to split apart on cue. Both the head concept and the photographic approach were subsequently abandoned.

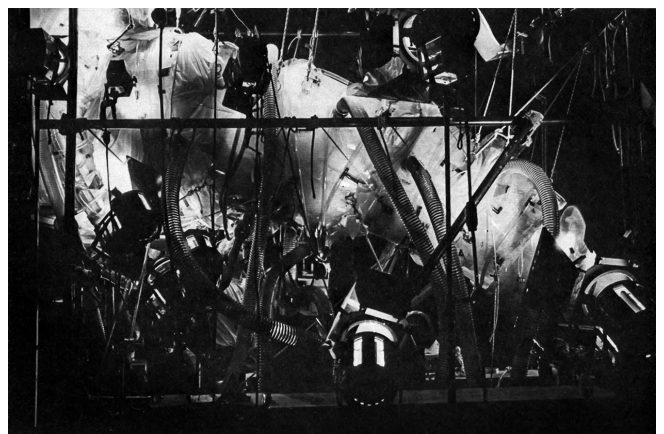
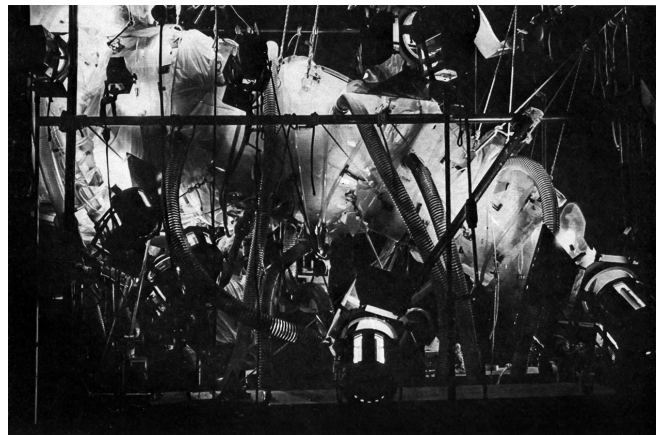


Cuesta Verde developer Teague is blasted by a shock wave as the Freeling house begins to implode. Shock waves

were generated by Gary Platek through a laser scanning technique, and were optically altered in color.



In the netherworld's final assault on the Freeling household, the children's room is again upended and the closet transformed into a giant, gaping esophagus.



The esophagus was constructed as a half-scale miniature, and then optically composited with the live-action stage

photography. Over a foundation of plexiglass rings, Rick Fichter inspects the preliminary work on one of the esophagus rings. Suspended from a pipe frame, the basic form was fashioned from various foams and styrenes. A circulatory system was filled with colored water, and a battery of vacuum pumps created an undulating movement. Since the construction materials were largely translucent, most of the lighting was effected from the outside.

Rick Fichter did an encore performance filming the new shot. “We had to create some kind of atmosphere that would occur between the foreground and the camera lens. Essentially what I did was put a lavender net in front of the lens, and then I lit up the portion of the net between the miniature door and the camera — which produced the effect of smoke. I could control the amount of ‘smoke’ in the room by eying the amount of light cast on the lavender.” The shot became dangerous because of the light intensity. Craig Nelson had to wear special neutral density contact lenses to prevent blindness. Several crew members weathered painful carbon arc burns. “I didn’t realize that you couldn’t even have the arc light strike your eye from an obtuse angle,” Fichter admitted. “But I found out on our original doorway shot that it didn’t matter — *anything* reflecting into your eyes could hurt you. I wound up with a patch over one eye for days. It was really quite painful.”

Of all the visceral elements in *Poltergeist*, the giant esophagus is the most potent. Again, idea and image are totally surreal — a child’s bedroom closet transformed into a gaping maw, from palate to uvula to whatever lies beyond. “The first time I heard about it,” said Paul Huston, “it was simply that a big throat needed to be made. Sometime after that, Craig Reardon did a sculpture on quarter-inch scale — kind of a closet door and an organic tunnel. A bunch of us in the model shop sat down and talked about giving it convincing and complex motion — and *lighting* it. Lighting a tunnel is always a problem. I figured it would have to move inwardly and have the ability to constrict, and that it would probably be a good idea to have a rigid outer structure with a flexible inner structure. Air pressure seemed to be a good system to use.”

It became obvious to Huston that transparent materials would enable the throat to be lit from the outside, thereby increasing the camera’s flexibility. Moreover, the whole look of the esophagus could be altered merely by changing the lighting. “With Charlie Bailey, I started building the structure. First I made a small conceptual model out of plexiglass and then scaled it up to a larger plywood form with plex rings fabricated by a place in Oakland. On the conceptual model, the problem was: How do you support its shape? The keyword was flexible motion, organic. I felt that hanging those plex shapes on a pipe frame with bunjy cords (thick rubber bands in nylon casings) would give it tremendous advantage. You could put the frame on wheels and transport it anywhere on stage. And if the sections were clipped on by bunjy cords, they could be taken down and worked separately.” Thus, each ring was suspended with a rubber band arrangement. The frame was like an open box, with the sections roped into the framework on grommets. When the framework was shaken, all the pieces would go in different directions. Or each could be moved independently.”

Concurrently, Huston did research on silicones, transparent foams and vacuum systems. “I had some foams called zero-volume foams. They’re used in fuel tanks to keep fuel from sloshing around. They make it by gassing foam rubber and burning it quickly, or setting up an explosion in a

vat. It blows the walls out of the rubber, so what remains is a tiny framework of struts instead of bubbles. If you put a cover on it and evacuate it, it just goes down to zilch! It looked so organic and disgusting, it was kind of a breakthrough.” From then on, it was a matter of Huston putting it together. Styrene domes were incorporated, and styrene bubbles covered them. With the foam skin pulled over them, a warty shape resulted. Sculpting the skin was problematic, since he was trying to do large areas at once.

At about this point in time, ILM began investigating the practical properties of Cyalume — a ghastly chemical compound manufactured by the Cyanamid Company — better known as “glow juice” in amusement park circles. “We were thinking about making a network of veins for the esophagus and circulating the juice through it,” said Huston. “But it turned out, the chemical wound up eating most of the materials it came in contact with! Also, once the glow juice was catalyzed, it had a brilliance span of only about five minutes before it noticeably declined.” In no time, the glow juice idea was abandoned and the veins were pumped with colored water.

A fairly sophisticated pumping system was needed. Since Rick Fichter would have to shoot at sound speed, the cycle of in-and-out air movement would have to be one to two seconds, due to the large volume of air involved. “There was a company that was going to rent us a pump — for three thousand dollars a month,” Lorne Peterson grimaced. “Plus we’d have to have this huge air reservoir. We finally arrived at a multiple vacuum cleaner motor system. It roared like crazy!” The esophagus, for all practical purposes, became a grotesque, breathing entity. Huston and stage technician Thaine Morris collaborated on the pumping system — comprised of homemade plywood vacuum chambers, with solenoids and plywood paddles. Two rubber bladders were attached to each plexiglass ring, with four motors and four valves for each ring. Huston was able to get monstrous breathing movements out of twelve bladders by connecting the valve mechanisms to an organ-like keyboard consisting of eight keys. Spielberg liked it. “He was there one day when we were shooting,” Peterson beamed. “There was this incredible construction of bunjy cords, lights, gels and pipes — all lit with vivid coloration. With the organ system, you could get it to undulate, or play out one gross, sequential movement, merely by running your finger across the board. Spielberg was captivated by the look, the incredible noise, and he wanted to operate it. So he assumed the position behind the cameraman and went on for a while. After all, he’d paid for it! I came back into the model shop. Later, when he and Frank Marshall were leaving, I heard Spielberg say: ‘Boy, this is the best day I’ve ever had. That was the most *fun* thing! I mean, if you’re gonna make a movie, you might as well have something that’s really fun!’ Needless to say, he was pleased.”

Richard Edlund and Bruce Nicholson had their woes with it, though. “The esophagus was shot half-size,” said Edlund, “and matted into a room where there were flopping blankets and Robbie’s legs kicking in the air. I felt it necessary to have people crossing the matte line; otherwise, it would just look like a matte shot. That meant a lot of articulate roto-matting. We shot the esophagus against black. That gave us more flexibility in the long run. We extracted a density matte to composite it onto the doorway — using the original negative of the shot as a cover matte. In the case of the esophagus, the black background was rendered clear on the negative. By printing extra footage of the shot with a blue filter, the reddish-pink esophagus was rendered dark. This became our intermatte.’ Since the shadow areas look clear on the negative, roto opaques it out, and the result is your matte. You’re capitalizing on the density of the exposed image. And you get a more subtle-

edged matte than you would if you just shot it and rotoscoped the whole thing, because you're retaining the original edge characteristic."

Other approaches were considered. "At one point," Edlund elaborated, "they were trying to decide whether they should have it built on the full-size set. They decided against it. But Steven was intent on having it look as though it were built on the set. We didn't do it bluescreen for a variety of reasons, one of them being that there was no accessible bluescreen setup on the M-G-M set. Some shots had the room inverted on gimbals. There were also wire shots, with kids fighting the suction of the esophagus. It's difficult to rig all that up and shoot it bluescreen, although that was certainly a possibility. The way I finally set it up, the plate we shot had the bedroom and just a doorway. The doorway contained a big sheet of Rosco process screen, used for diffusion, and the doorway became our key light. We tried at first to cheat the lighting from above, but it didn't look right. I think much of the eeriness of the shot had to do with the light from the doorway."

"We had to change the timing on the plates," Nicholson added, "just because of the lighting and the color of the esophagus. That wasn't too severe. But there was a lot of trial and error. We actually had to opaque or vaseline-out certain areas of the matte edge. And we changed the lighting on the plates in certain areas, where there would be an intense highlight on the floor. It turned out much better than we originally thought it would. Mark Vargo did some excellent printing work on that sequence."

"The daily screenings for *Poltergeist* were where most ideas were introduced and modified to fit," commented Edlund. "In the esophagus scenes, the precomps were done and redone. Bruce and I had endless discussions on adding this little bit of diffusion here and dodging this section a little bit there to make it all lay back on the wall. For a long time, it looked like a postage stamp stuck on an envelope. Until the final bit of finessing was done, it just didn't work at all. Then all of a sudden, the shot would just come to life."

Cost of one ILM esophagus — \$100,000.

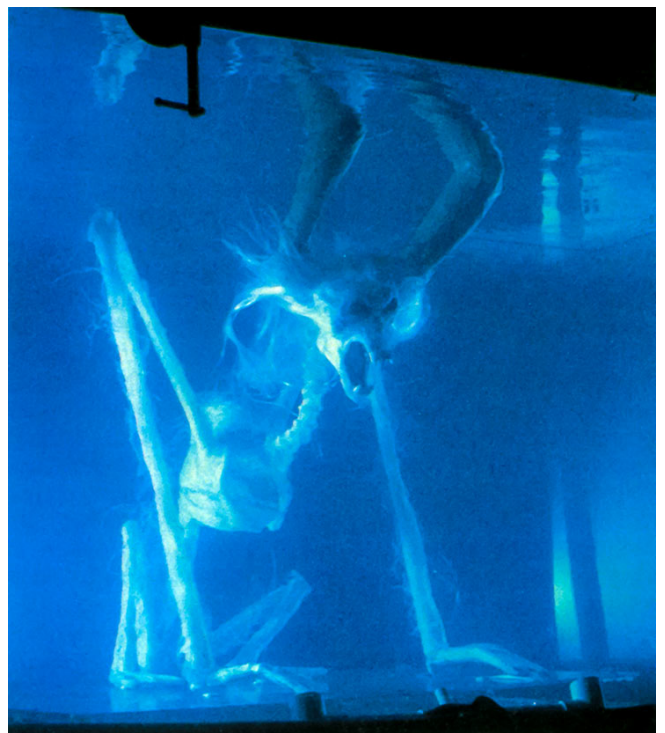
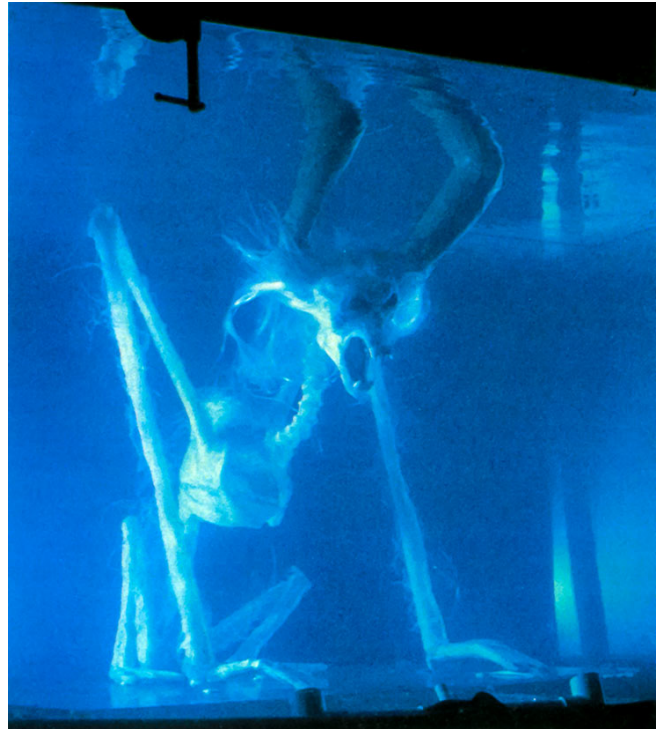
The Beast in the Hallway, a gangly horror designed by Nilo Rodis and John Bruno, appears near the end of the film when Diane Freeling runs toward the afflicted bedroom to save her children. The creature was ILM's original excuse for ordering Cyalume glow juice, the idea being that the material would be pumped into its tubular circulatory system for a ghastly, light-emitting effect that had never been seen before on the screen. "The creature had been drawn by Nilo," said Craig Reardon. "I thought it resembled *Leo the Lion*, but it had a nice, gangly, gobliny look. I went up there, built the framework and sculpted it, made molds and turned out the skins. They had this notion of using 'glow juice' in the creature, which they wanted to have fan out in a blood vessel network. As it turned out, they were buying a real headache. For one thing, it's very difficult to pump anything through *anything* because of hydraulic pressure. Plus this stuff presented the added nightmare of requiring constant circulation to facilitate the flow. It was already determined that *the Beast* would not be on the screen for more than eight seconds, and that they'd shoot it in a water tank so the hair would float in a ghostly fashion. This was a great idea, I thought. They asked me to contribute suggestions as to how it could be animated. I suggested that they take the silicone rubber casting, which was loose and floppy, counterweight the hands and the head, and put it on strings with its feet fixed in place — a marionette, in other words. They'd have the flexibility of shooting in a variety

of takes with *the beast* in different, gangly attitudes. They looked at me rather dubiously, and said: ‘Well, what about an armature?’ They expected to have an armature in it, and yet it was supposed to be transparent! Well, a great deal of time was then spent by having Dave Sosalla construct a clever armature rig inside the thing, by fitting it to the mold. He must’ve spent three weeks building it. It was wrongheaded only because it could only operate in one or two axes of movement. Once the body parts were married to this complicated rig, the whole thing got to be like a washing machine with wings. They couldn’t do anything but jettison the entire body! All that they retained of my sculpture was the head.”

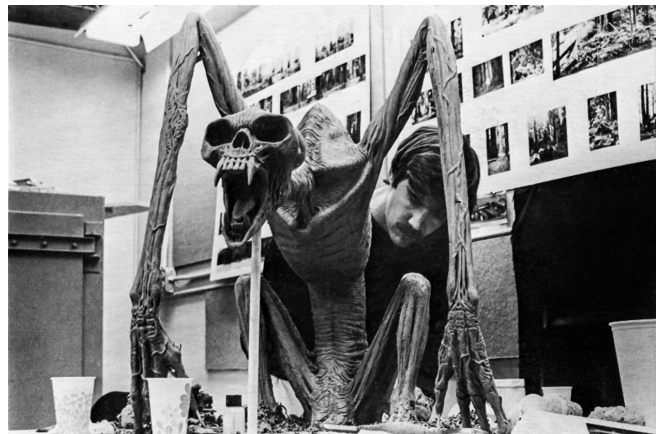
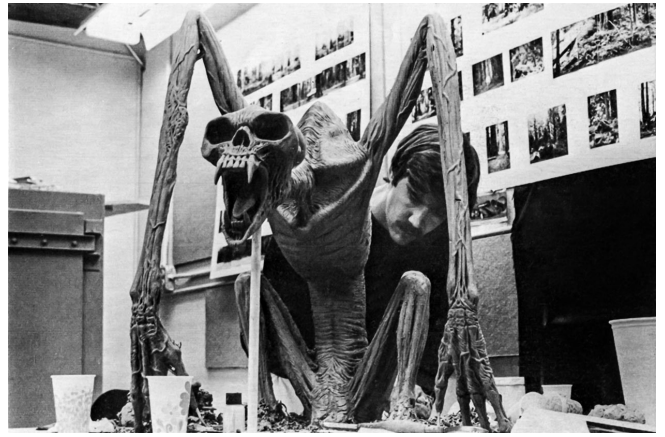
“Initially it was a question of intensity and look,” Richard Edlund commented. “For a while, we wondered if it should look like the Head in the Closet — whether it should interrelate that way. One of editor Michael Kahn’s unforgettable comments was: ‘None of it makes the *least* bit of sense, but it all works.’ We did build *the Beast* based on the glow juice idea — toxic, awful stuff! We spent an enormous amount of money on it. I thought it would be just great and it wasn’t — it’s my fault. It cost thousands of dollars and we didn’t use it — for one reason, because nobody wanted to work with it. It’s one of those weird toxic substances that makes you wonder what’s going to happen to your grandchildren. Craig’s model didn’t have the moves. We probably should have used it as a concept rather than the actual thing, because he didn’t do the mechanicals on it and it became too hard to create the bones after the ‘meat’ was made. So Nilo got into a crash program with Lorne and they came up with a marionette concept practically overnight, using the same basic skull but redoing the body altogether. Then we set it up in the tank and shot it underwater.”



When Diane Freeling rushes to her children’s aid, her way is blocked by a hideous beast.



The actual creature was a lightweight marionette photographed — with a slight anamorphic squeeze — in the ILM water tank so the filmy hair covering its body would float in a ghostly manner. Camera angle and alignment were especially critical.



The original beast concept, designed by Nilo Rodis-Jamero, was sculpted by Craig Reardon. To facilitate articulation, however, the body was later revised and simplified by Rodis and model shop supervisor Lorne Peterson.



Modelmakers Larry Tan and Jeff Mann work on a detailed replica of the Freeling house for the sequence in which the entire structure implodes and disappears into a spot of light.

Lorne Peterson was also head animator on the tank creature. “The new one was extremely light,” he said, “perhaps five pounds. The old mechanism weighed maybe thirty. This one had plastic tubes for bones, and rubber skin. Urethane sinews were put in, and a cobweb urethane was spread over that. We added ‘angel hair’ for the real filmy parts, building that up. Originally it had a rib cage of thin plastic; I did a clay head and rib cage and vacu-formed it to get the ribs. They were linked loosely; so if you let go of a string, it would kind of fall into a pile. Three of us operated the thing on a scaffolding, looking at a monitor. Bill Neil shot it, and he was looking at a clip in the viewfinder. We had to be guided with constant, audible cues, and it probably took longer to shoot it than to make it. We put crayon markers on the TV monitor so we could define our parameters. Still, three people manipulating it was tough.”

“We shot it against black,” said Edlund, “so we could extract a density matte. We wanted a certain atmosphere in the tank, but we found that the black background tended to go grey when we introduced this atmosphere. Difficult to control. During dailies, we projected a slide of the background plate in tandem with the test footage — lined up exactly. We even did quick test composites — superimpositions — to make sure we had it perfectly aligned before we struck the set; because if the angle and perspective were not just right, *the Beast* didn’t look like it was actually in the hallway. It was really critical. I even had Bill Neil use an anamorphic lens on the creature, which squeezed it on the side so we could narrow him up a bit. At the end of the shot, Jobeth runs in front of him by means of rotoscope. Jim Keefer did that, and it worked really nicely. You don’t get any feeling of edges or matte lines. Bruce and I spent *hours* going over that shot, trying to get the density matte and balance just right.”

Although *the Beast* in the Hallway and the new Head in the Closet were both shot in February 1982, the last major *Poltergeist* effects sequence — in order of screen appearance — had gone before the camera five months earlier. The imploding house — Frank Marshall’s “\$250,000 sentence” — was, in ILM’s estimation, the grandest illusion of all, something that truly had never been done before. “The plate was shot on location,” Richard Edlund recounted, matter-of-factly. “We matted out the house entirely, and Mike Pangrazio painted in the front yard and the building site. That was fairly routine. What *wasn’t* routine was dealing with the house. Obviously, it had to be a miniature of some sort. But there was no way we could blow the thing up and print it backwards, for instance, because it



An interior view reveals a network of wires affixed to various parts of the home. These small wires were arranged in sequence and attached to heavy-duty cables — which when pulled, would bring the house crashing in on itself. Modelmaker Ease Owyung was in charge of the four-month development and construction project.

was supposed to be imploding. So essentially what we had to do was take a six-foot miniature and pull it through the eye of a needle.”

Lorne Peterson backtracked to Day One. “We had an initial roundtable discussion as to how we were going to do the house. We originally thought of it as being the reverse of the old ‘magician’s bouquet’ trick, where the folded paper flower springs out of the wand. Our idea was to take the ‘bouquet’ and draw it back in so it all folds into place and goes down a hole. This was quickly ruled out, however, since it would only fold up in an organized way, rather than look totally annihilated.”

Ease Owyung, who was charged with designing and constructing the collapsable miniature structure, knew he had a problem on his hands. The first logical step was to try out different materials. “First we made small plaster houses and stuck them in a vacuum chamber. That didn’t work very well, because the weakest point of the house would fail and then everything would just rush through it. We tried balsa wood that had been sealed, but that didn’t work either. Finally, we abandoned the vacuum idea and decided that we’d have to physically *pull* the house through a hole and shoot it high-speed.”

Owyung and crew rigged a rough miniature mockup with wires and hooked it up to bunjy cords for quick implosion. But the house was too strong, and the bunjy cords too weak. “There was also a problem in getting materials to behave the way we wanted them to. We wanted to use plaster or Durham rock putty, because we liked the way it disintegrated; but the first test models were thick enough to resist the forces we were using. Then we tried spraying a layer of putty on rice paper. When it dried, you’d get a thin sheet of plaster on paper — which would disintegrate easily, but it needed reinforcement. Balsa wood, surprisingly enough, turned out to be too heavy. We tried foam strips. Then, after getting the right combination, we did some tests. The first test on stage was just of materials. We made walls and attached cables to them. Initially we were going to use levers. We had this scaffolding with the house on top, and cables attached to the house ran down to a lever system. We were also testing *sequences* — which parts would fall at different times. When the camera rolled, someone would yell: ‘Go!’ Each person would pull certain cables in sequence. But it turned out the levers weren’t powerful enough. The geometry of the building was just too strong. So we had all these guys yanking, but nothing was happening! Then one section would fail, and that would be the *only* thing that did. We knew then and there that we couldn’t use the sequencing idea, at least with people pulling. It all had to happen so quickly, and the crew couldn’t react fast enough. Finally, we decided to use a forklift to pull everything through. That worked fairly well. Our test house broke up — but it still didn’t go through the hole. The hole was six by eight inches, and the house was six feet! The cables would snap. So we hooked them into nylon nets imbedded into the walls — siliconed in. On the second try, we *still* couldn’t get the damned thing through the hole. We found then that once a part of the house failed, the whole house would just collapse. And collapse didn’t mean implode.”

Owyung finally decided on an inner structure of hardwood. “The wall would rest against *the wood*; and if you pulled on the wall, it would break and give in, yet the whole structure would *not*. That had to be designed without it being visible.” Timing tests transpired; and one overall systems test was conducted to see if the forklift, the cables and the mockup interior structure all performed as planned. “The problem *then* was that the whole house didn’t disappear. We realized that we needed thicker cables, and got hold of some quarter-inch, 1200-pound variety. I knew *that* wouldn’t snap. If

anything, the whole scaffolding would pile down first. To sequence the collapse, we had to stagger it by lengthening the cables for different areas. Some of the cables looped around separate parts of the house to get a sequential collapse. We had about forty tiny cables and a couple of big ones.”

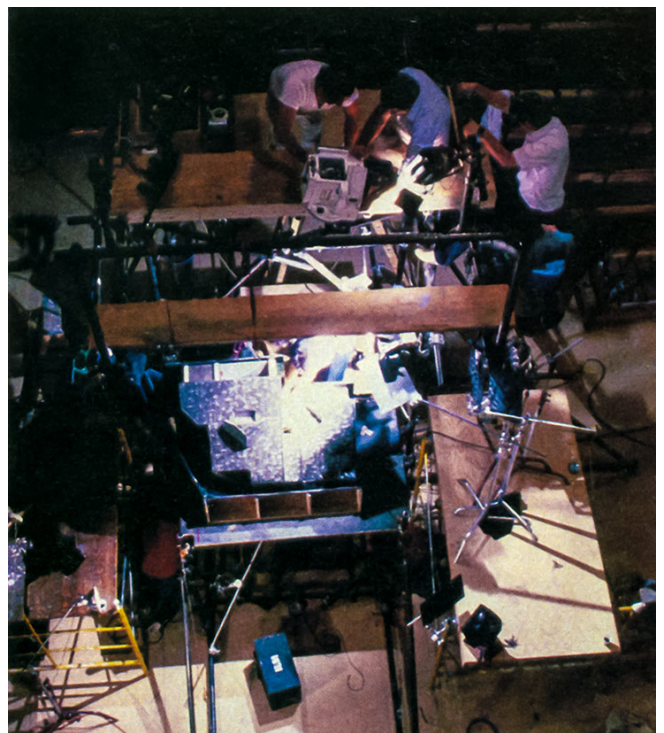
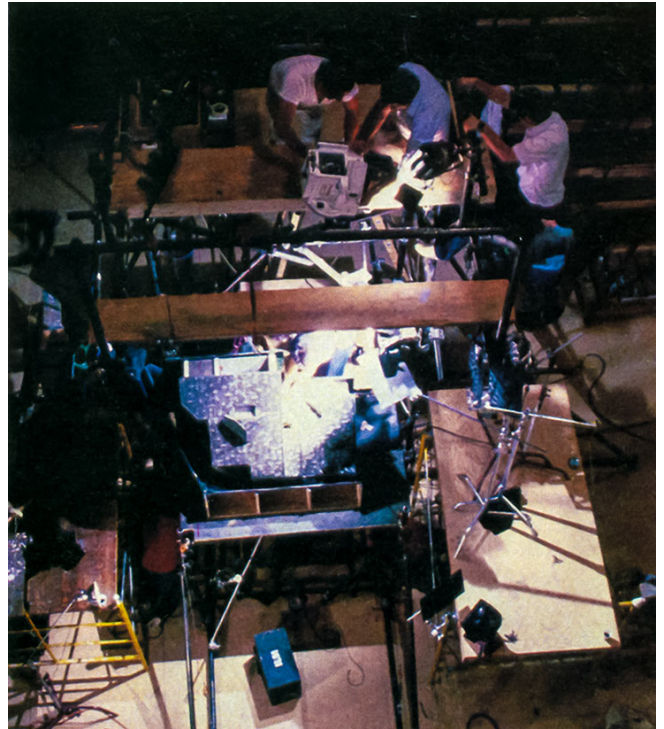
The final house — identical in every detail to the actual on-location structure — took four months to complete. To insure visual credibility as it collapsed in on itself, the final walls contained fake foam studs, balsa wood facades and a pine interior. And in case they showed during the debacle, tiny garbage cans, TV sets, drapes and furniture were built on a 7/8-inch scale. Jeff Mann did all the furnishings, hand-carving them out of foam. Barbara Gallucci applied the stucco texture, painted the house and did the roof.

For the actual take, the front of the house was positioned over a funnel-like chute, facing straight up. The camera was shooting down from the ceiling. The actuating cables extended down through the house and out the chute. A large venturi-type air mover was hooked up to draw away residual debris and keep the passageway clear. The main cables connected to a forklift, and the overall scaffolding framework was bolted down securely. At last, everything worked.

Bill Neil photographed the shot, using equipment and expertise provided by the late Bruce Hill, who for years had been the industry’s leading specialist in high-speed photography. “Since the shot was done at 360 frames per second,” said Richard Edlund, “we couldn’t do it with a VistaVision camera, even though our background plate was VistaVision. As a result, we had to shoot it 35mm anamorphic and then blow it up to VistaVision format on a printer that I’d put together when we were doing similar type work on *Raiders*. Even so, it was difficult to line the two elements up precisely. Then, in addition to that, we had to deal with a matte painting and several animation elements — including light reflections and the bilocation light itself, which couldn’t actually be there because it would have been crunched up and covered with debris.”

“The shot also involved a lot of articulated roto-mattes,” said Bruce Nicholson. “There was no way we could have shot it bluescreen. There were lots of shadow areas, and all the tiny pieces would have been incredibly difficult to deal with. We were able to derive certain photographic mattes, but most of it was rotoscoped.”

One of the corollaries of high-speed work is that increased shutter speeds equate with decreased exposure times. As a result, the light requirements are increased accordingly; and with massive amounts of light flooding a setup, it is often difficult even to see, let alone get an accurate light reading. Bill Neil wore welding glasses during the shot. Despite preliminary exposure tests, the imploding house element was slightly underexposed. “I was crushed by that,” Richard Edlund confessed, “because I knew we were going to lose a lot of the detail we wanted to keep. I wanted to reshoot it, but it would have cost another \$50,000 to do so.”



During photography, the house was positioned over a funnel-like chute, facing straight up, with the cables extending down through the back of the house and out the chute to a forklift. Stagehand Dick Dova, cameraman Bill Neil and the late Bruce Hill set up one of Hill's high-speed cameras on an overhead platform. Since the camera angle had to match the background plate precisely, no backup system could be used.



The completed house. I league watches as the house implodes. The final effect combined miniature photography, matte painting and cel animation.



The completed house. I league watches as the house implodes. The final effect combined miniature photography, matte painting and cel animation.

Edlund was overjoyed, however, when he went to M-G-M for the timing session and found that the imploding house had duped better than just about any other shot. "I'm not sure why," said Bruce Nicholson. "One of the reasons may have been that we were getting our dailies back on 5383 color print stock. M-G-M did our release prints on 5381, which has a bit more exposure latitude in the black tones. Ours were washing out. Everyone was amazed. The timer had brought the exposure up about four points, and it looked terrific! It didn't even look like a dupe. We were very happy about that, especially after all the time we spent on it."

Though the ordeal of the imploding house would seem to be the last item on *Poltergeist*'s effects menu, there is yet another tale to be told. The Saga of the Glass Hands — a last-minute anomaly — began in late February, during one of Steven Spielberg's sporadic visits to the ILM *Poltergeist* camp. For the first 'ghost' shot in the film — the TV shot," said John Bruno, "Steven decided that he wanted to have a live-action hand turn into animation — which had me worried, because I didn't think we could make that kind of transition realistically. I decided to roto it, making it look somewhat skeletal and deteriorated. We wanted to keep all our ghost apparitions feminine, so I did some film tests with Renee Holt's hand. We applied finger extensions to her, which gave her four joints on each finger. Conrad Buff and I cut the footage down, and I was going to roto it using tonal colors. Then, when it reached a certain point, it would turn into our animated ecto. Steven said it made him jump, and approved it. Somewhere during this time — while we were experimenting with Renee's fingertips — Scott Marshall had made a mold of his own hand and poured silicone into it, and this transparent hand was sitting on his desk in the model shop. That got me thinking. I took it in to Richard and asked him if he had an open mind."

Bruno's idea was that rather than use an animated hand, a series of transparent castings — one for each frame of the effects cut — could be photographed sequentially in such a way that a solid spectral hand would seem to stretch forth from the television screen and then dissipate into animated ectoplasm. Bruno and Lorne Peterson got together and worked up a budget for the shot, and then Edlund approached Spielberg with the idea and got his go-ahead.

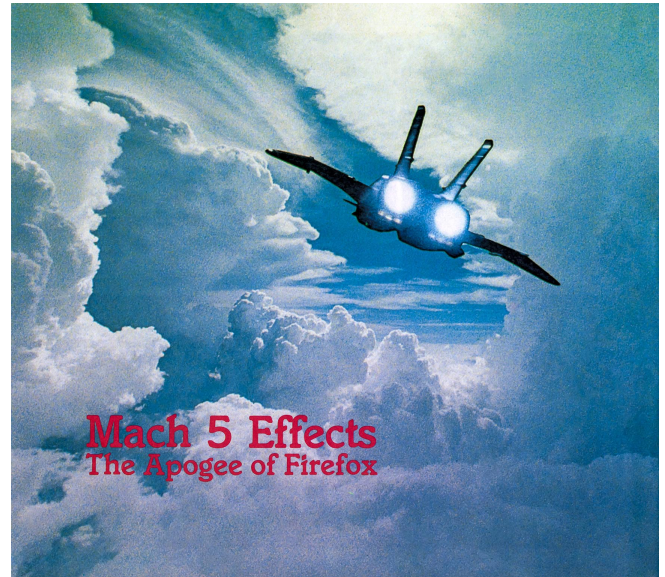
"Terry Windell and I did another cast of Renee's arm," Bruno continued, "one as it would be at the beginning of the shot and one as it would be at the end. Then we did a number of intermediate wax castings — about twenty-five or thirty of them. Sean Casey was in charge of the molding. Then we started trying to match the wax arms to our pencil tests, repositioning and resculpting them for each successive frame. We brought an Eigen video animation camera to the model shop to test the poses of the hands. Then we made some plaster molds of them and put those in the rubber room, which has a big oven. Once the plaster was dried, we melted out the wax and could then make our clear hands from silicone. That involved a lot of work, because they had to be sanded over and over and coated with additional layers of silicone to make them real shiny. Then, during the actual photography, since the screen had to stretch out with the hand, we had to literally replace each hand and TV screen per frame! Also, we had a front projector projecting slides we had taken of the TV snow patterns. The dailies looked great; it worked beautifully. But it was only a second of film. The next move was to devise a transition, so I rotoed the glass hands to match them to the next set of animation drawings. I also had to animate up into that hand, causing it to get 'white hot.' Then Conrad and I spent six hours timing it; Mark Vargo in optical did the compositing. Except for a little black tick in our precomp, it worked perfectly. The whole studio was in the screening room for that

shot, and everyone was pleased. The next morning, the call came in from Steven. ‘It doesn’t look scary,’ he said. ‘The animation looked scarier.’ We spent the next three days redoing the shot with animation.” What had, in fact, been the single most expensive shot, per frame, ever produced at ILM went to its final resting place on the editing room floor. Indeed, the effect in the final film is straight cel animation, augmented with a few optical enhancements.

After ten months of effects work, *Poltergeist* was at last finished. The payoff for Richard Edlund came in the form of a sneak preview at the national Theatre in New York City. Gathered for the occasion were Steven Spielberg, Frank Marshall and Kathy Kennedy — along with interested bystanders Harrison Ford and Melissa Mathison — and together they all sat in the back of the house. Edlund was bowled over by the response. “It was a great, hip New York audience. And they were just voraciously hungry for *every detail* of the picture. The audience got every joke, every nuance that Steven threw in. They were absolutely enthralled by it. That was the true payoff — seeing *Poltergeist* with a really great audience.”

Of course, the wonder of *Poltergeist* lies not in its dazzling visual effects, but in the shrewdly calculated scheme of a consummate filmmaker. *Poltergeist* may be a roller coaster ride requiring a goodly dose of Dramamine for the average viewer to sustain its multiple climaxes; but ultimately, its operative mechanism is that of childhood fear, of nascent phobias and vivid nightmare tableaux. As with *Jaws*, the latent terrors of *Poltergeist* will reverberate for a while. Many among us will never again be able to look at an “off the air” video transmission with total detachment. And grammar school audiences may well choose wisely in removing that leering clown doll from the moonlit window sill and locking it securely in the toy chest... where it belongs.

Poltergeist photographs copyright © 1982 by Metro-Goldwyn-Mayer Film Co. All rights reserved. Production unit still photography by Bruce McBroom. Effects unit still photography by Terry Chostner, Roberto McGrath and Kerry nordquist. Special thanks to Susan Trembly, Laurie Vermont and Chrissie England.



Mach 5 Effects The Apogee of Firefox

article by

Paul M. Sammon

The marriage of computerized special effects systems to the motion picture industry has, not surprisingly, resulted in the production of pure fantasy. State-of-the-art effects films have been characterized by their futuristic and/or fantastic themes — science fiction, space opera, heroic fantasy, and the like. The *contemporary* effects film still seems a limited field, and it's the starship that's become most emblematic of the best motion control technology, a symbol that is rarely broadened to include the prosaic world of airliners, helicopters and jets.

Until *Firefox*. Before this \$18 million Warner Brothers release, aeronautical and effects buffs had to be content with those lumbering transport models found in such Thirties and Forties films as *Five Came Back* and *Bataan*, or the wire-rigged miniatures of *The Bridges at Toko-Ri*, or the plate and process techniques used in *Dr. Strangelove*. What makes *Firefox* unique is not only the change-of-pace presence of an international "action" star — Clint Eastwood — involved in a gripping espionage thriller, but that that thriller is also a special effects showcase utilizing breakthrough technology developed by John Dykstra's Apogee, Inc. — techniques which realistically portray and revive an old cinematic genre, the fighter pilot movie.

In 1977, *Firefox* began as a best-seller. Author Craig Thomas blended spies and supersonics in a sleek, slick novel revolving around the combined efforts of the CIA and British Military Intelligence to hijack the titled warplane — a Soviet MiG-31 which is not only invisible to radar and can fly in excess of 4000 miles per hour, but also contains a lethally sophisticated weapons system controlled by its pilot's own thought impulses. A psychologically traumatized crack pilot, Mitchell Gant, is then pressganged into the plot. His mission — steal the *Firefox*.

Thomas' novel handily cracked into two parts, the first being the efforts to infiltrate Gant into Russia, and the second a long chase sequence as the Soviets desperately try to shoot Gant out of the air as he pilots the pirated warplane across the top of the world towards a friendly Western country. In continuous print since its initial publication, *Firefox* the novel offered equal amounts of tension, excitement and exhilaration, the elements which reportedly attracted superstar Eastwood to a proposed film adaptation of the book in the first place.

According to Robert Shepherd, Apogee co-owner and *Firefox*'s supervisor of special visual effects, "Clint was really taken by what he saw as *Firefox*'s basic kineticism. More than that, he responded very well towards a good, exciting script." That screenplay had been presented to Eastwood's Malpaso production company in 1979 by fledgling screenwriters Alex Lasker and Wendell Wellman. At the time, Eastwood was heavily involved in *Any Which Way You Can*; still, the actor not only decided to star in a *Firefox* adaptation, but to produce and direct the film as well. As one of his first concerns, Eastwood turned his mind towards the acquisition of a special effects house — one that could realistically portray the many aerial highlights that were to fill the film's concluding forty minutes.

Initially, Eastwood contacted Douglas Trumbull's Entertainment Effects Group. Trumbull was at first responsive to the *Firefox* project, and both he and Eastwood began to cull the team which would have to grapple with the film's primary problem — the design of the MiG-31 itself. To this end, Trumbull enlisted the services of master miniaturist Greg Jein.

"An art director named Bill Creber had become involved with Doug in the negotiations to work out a basic design for the *Firefox*," Jein recalled, "and then Doug called me in to help. After accepting, I researched a number of visual representations concerning current aviation designs, with the thought that I would ultimately want the *Firefox*'s appearance to look different enough so that it wouldn't be a rip-off of an American F-5 or F-18. I also took into account contemporary Russian aviation technology, such as their fondness for *heavy metal* plating. With that approach, I was sure we could come up with a specific state-of-the-art ship which would have its own identity, and not simply reflect a general purpose design."

Jein quickly found that Eastwood also had strong beliefs on the "look" of the fictional MiG-31. "Clint himself was easy to talk to, and he always had good ideas. At one point, we were informally kicking around what finish to use on the plane and he said he wanted a nice, shiny surface. He also mentioned something about making it black. Actually, although the shininess was retained, my *Firefox* was not black at all. It was a shade of very dark gunmetal, Russian standard gray; the final Apogee stage model was a sort of charcoaly blue-gray.

"One proposed *Firefox* design had already been penciled in on paper when I arrived at EEG, a design which Creber and Trumbull had come up with. Ultimately, that was let go because the general feeling was that the shape was a bit too fat to be practical. So Bill and I kicked some more designs around on paper, eventually coming up with eight of them, including the first version. It then got to the point where we carved foot-and-a-half long foam mockups of each design. That process took about a week and a half. And it was while I was doing the basic foam whittling shape on the second design, which had been generated by my pencil drawings, that I came up with the idea of the 'soldering iron head' on the nose of the *Firefox*. Clint and Doug had wanted a unique nose cone for

the ship, both for visual excitement and for the fact that a flat shape would facilitate an easier opticals job.” Ironically, it was this early, second design — soldering head and all — which was picked over the six later proposed prototypes as the basic *Firefox*.

By the time production wrapped on *Any Which Way You Can*, some two hundred *Firefox* drawings had already been prepared by Jein for the initial effects storyboard. Shortly thereafter, however, Malpas and EEG parted ways, and Bill Creber was laid

off. Greg Jein, however, was retained on the preproduction team. After his fourth refinement of the *Firefox* design, the modelmaker produced a vacuformed quarter-inch scale miniature of the plane and presented it to Eastwood. The producer/ director/star approved. “That was when I first heard that Clint was in negotiation with John Dykstra,” Jein recalled. “Still, Eastwood must have made up his mind that no matter who else became involved, the *Firefox* design was already nailed down, because he told me to go ahead and make a four-foot study model — something he could use to show Apogee what was going on.” Jein then hired Mark Stetson, Bill George, Dave Heilman, Robert Short and Pat McClung to help him assemble the study model. “The four-foot *Firefox* was carved out of wood. Then we made a rubber mold for it and cast the final product in epoxy.” Sean Casey did the mold work.

After the study model had been completed and delivered, Eastwood’s negotiations with Dykstra were also concluded; and in February 1981, Apogee was hired to provide *Firefox*’s special effects. Due to Jein’s increasing involvement with the complex neon-lit miniatures for Coppola’s ill-fated *One From the Heart*, and Stetson’s commitment to *Blade Runner*, the first *Firefox* design and model-building team then disbanded.

Apogee’s 30,000-square-foot production facility is located quite near the Van Nuys Airport — a nice touch for an aviation film like *Firefox*. One can constantly hear the drone of overhead aircraft from John Dykstra’s office. Once the production center for the now-mythic *Star Wars*, Apogee is comprised of ten fully-staffed departments and can complete all production design and processing without the requirement of additional out-of-house assistance. Apogee is also a comfortable mixture of commerce and counterculture, where large, well-behaved Irish setters can be found peacefully asleep before the doors leading into motion control stages.

“Apogee actually consists of nine equal partners,” explained blond, bearded John Dykstra, who himself seems an equal mixture of engineer and Viking. “Those nine folks are Al Miller, Bob Shepherd, Don Trumbull, Grant McCune, William Shourt, Roger Dorney, Doug Smith, Dick Alexander and myself. It turns out that this parceling up of the company functions pretty well, since our work is generally broken down into about nine equal portions by the time we’re through with it.

“Once we’ve accepted an assignment like *Firefox*, we’re very much like a conventional studio in the way we go about preproduction. First, we thumb through the script and outline the action — whether it’s camera right or left, how big things are going to have to be, et cetera. Then we storyboard. Marty Kline handles that for us, as well as design work. He’s been doing effects boards for us for about three years now. Upon completion of the storyboards we bring our nine people together. At this point, Bob Shepherd is heavily involved with our budgeting for the project. He and I sit down with the others, and the boards, and determine what our costs will be. Once Bob has made up the budget, we begin construction. Generally, the miniatures are the first thing to happen.”

As Apogee's chief modelmaker, Grant McCune's first *Firefox* assignment lay in assessing Greg Jein's MiG-31 design. "Actually, that was the first and only model design I was ever aware of for the ship. I tried to get away from it a number of times — not due to any lacking on Greg's part, but because there had been some radical rethinking concerning the plane after Apogee came on board. Most importantly, we were going to try to fly some of the large-scale *Firefox* miniatures by radio control. Jein's design had, of course, never taken that into account. But Clint was still staunch about staying with the lines of the original plane. This forced me to keep my design modifications to a minimum. Mostly, these changes were in the wing shape and wing area, as I was trying to increase the plane's airfoil capacity and pump in some more area for lift."

While the radio-controlled *Firefoxes* were being prepared for use on Greenland locations, McCune and the Apogee model department moved ahead with the construction of a number of other miniatures. In all, nearly fifty different models were built for Eastwood's thriller. These included a clutch of variously scaled MiG-31s. Two were not exactly miniatures, however. One *Firefox* was a sixteen-foot underbelly section and another was a full-scale mockup. The majority of the *Firefox* models were, of course, of the more conventional variety. "There were about a dozen *Firefox* miniatures," McCune said. "Working from the bottom up, there were two nine-inch models used for long shots. Our primary motion control stage was only eighty feet long, and even with the widest lens you couldn't get the larger models to appear small enough. So we'd throw a nine-incher up instead. Then there were two 21-inch-long *Firefoxes* that were used in a number of different shots. Our standard size stage model, however, was 63 inches long. There were six of these — four being radio-controlled and two being our working stage models. Most of the motion controlled detail shots were done with the 63-inchers. We had those set up with a number of functions, such as moving ailerons and air brakes. I felt that those large stage models were particularly successful.

Impressive achievements were not confined to the model department, however. In fact, Apogee utilized *Firefox* to showcase a number of technical breakthroughs which had already been in development or under consideration at the facility. One of the first and most important — in terms of *Firefox* — was the INS, or Inertial Navigation System. "Through this system," Dykstra explained, "we evolved a method of recording the angular positions and rate of change of a genuine aircraft — in other words, of storing an in-flight aircraft's pitch, roll and yaw. And we could, through the INS, record this data at a frame-by-frame rate."

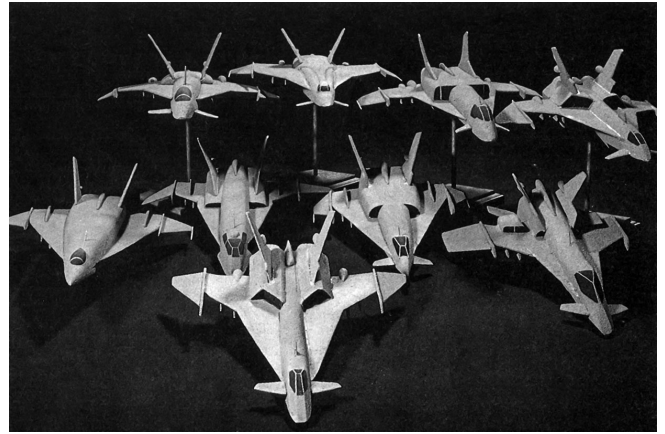
John Sullivan, who joined Apogee during *Star Trek — The Motion Picture* and was one of *Firefox*'s chief motion control cameramen, elaborated on the system's history and basic capabilities. "You always talk about neat new systems between projects, and at this facility we'd been talking about the possibility of using a gyroscopic platform, or an INS, as a means of recording motion

out on location. With *Firefox*, we realized that the ideal opportunity to crystalize this concept had fallen into our laps. Dykstra had seen one of the film's primary challenges as being able to realistically present POV pilot shots, and/or being able to place an aircraft within a naturalistic airborne environment — one within which an audience could experience a plane's movement in relationship to the horizon. The biggest obstacle to this was that since air is not exactly the smoothest of mediums, we were constantly going to be having displacement problems — which meant that those of us who were back on the stages were also going to have problems compositing the model planes into these backgrounds. Obviously, some type of information recording device attached to an aircraft's on-board cameras seemed the answer, one in which that information could be stored and later retrieved. That's where Al Miller and Mat Beck took over."

Alvah Miller is a nuclear engineer whose pioneering work in motion control greatly contributed to the success of *Star Wars*, earning him a Class II Academy Award in the process. The construction of Apogee's INS flight recording system was split into two broad areas, with Miller designing the electronics, and Mat Beck — another long-term Apogee team member — taking responsibility for the software development, a job he shared with assistant Susan Sitnek.

"At first," Miller related, "we really didn't know what camera speed ranges we would want once we had the system together. So we began with the assumption — later proved wrong — that our top frame rate would be close to twenty-four frames per second, and that we'd bottom out at around one or two frames per second. Through some initial calculations, we decided that those bottom rates would appear to boost the speed of a system-equipped jet ten to twenty times its actual cruising rate — up to from three to six thousand miles per hour. So that's where we started."

"Basically," explained Mat Beck, "the INS involves a system mounted inside an aircraft in which data regarding the plane's attitude is fed through an interface box which then turns the aviation-type, synchro-attitude data into digital data, which an on-board Apple II computer can then eat. In layman's terms, while the plane's camera system was recording background plates of clouds or mountains or water or whatever, the INS was simultaneously recording the attitude of the plane. Back at Apogee, we could then put the plates and INS data back together again, resulting in



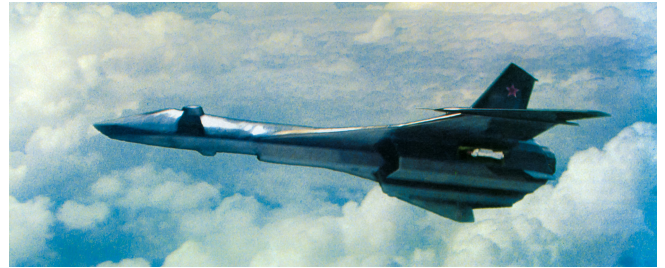
The design of the Firefox aircraft was one of Clint Eastwood's earliest concerns. Preliminary art director Bill Creber and modelmaker Greg Jein developed numerous ideas on paper, and then Jein transformed a number of the more promising concepts to eighteen-inch foam mockups for Eastwood's consideration.



Once Eastwood had made his choice, additional refinements were made, and then Jein and his crew fashioned a four-foot study model from cast epoxy.

completely synchronized movement with our stage models. It worked really well, if I do say so myself. Of course, there are always initial glitches...”

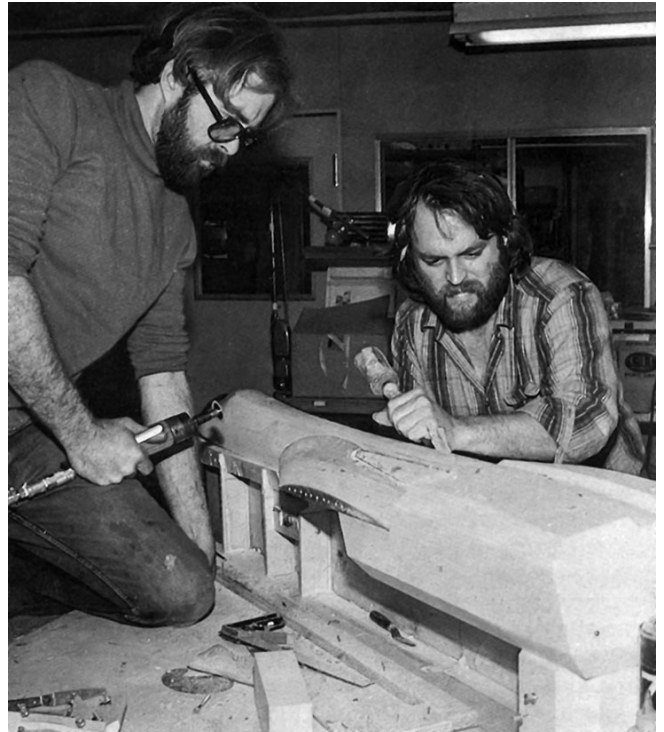
Al Miller elaborated on those initial problems. “Mat and I first put the camera controller together without any kind of automatic speed ramping. Originally, you achieved the acceleration/ deceleration effect by hand, off of a speed control potentiometer situated on the system’s front panel. It was just a little black knob. You set it to a particular mark and that would be your camera speed. But when we first went up in a plane and shot some material with it, we found that the potentiometer just



When Apogee subsequently took over the effects assignment, minor modifications were made to the basic aircraft design — primarily to make the craft more airworthy, since it was anticipated that radio-controlled flying miniatures would be used for some of the scenes.



Modelmakers David Beasley, Ken Swenson and David Sosalla build the mold from which six 63-inch Firefox models would be produced.



Peter Gerard and chief modelmaker Grant McCune carve out the basic Firefox shape.



Larry Wolfe installs radio-controlled engines.



One of the radio-controlled Firefoxes, piloted by Jay Replogle, takes off from a runway in Greenland. Unfortunately, weather conditions and rugged terrain effectively grounded the flying models.

didn't work that well. If you hand-turned that speed knob from, say, twenty-four frames per second to one frame per second, you were winding up with nearly the same amount of photographing time between one and two frames per second as you were between twenty-three and twenty-four. In other words, you were turning this knob, thinking you were accelerating your camera very slowly; but in actuality, as you got down to the slower frame rates, there was no smoothness to the process. It was as if something had literally kicked the plane in the ass. We were getting a tremendous jump in the imagery and going *extremely* fast. So we threw out the speed knob. Dykstra then decided we needed to go down even farther on our frame rates, down to perhaps as little as a quarter or an eighth of a frame per second. So, keeping that and our potentiometer problem in mind, we went in and completely rebuilt the controller that ran the camera. It was even in a completely different box by the time we were through with it. We came up with a simple rig where all you had to do was throw a switch that, in turn, automatically ramped the speed of the camera. This worked just fine."

The camera controller also included another function — an exposure compensator. This system took the desired exposure at normal twenty-four frames per second, along with the running speed of the camera, and from that calculated the required f-stop for the lens. It then drove a servo system to change the f-stop ring on the lens. The exposure compensator turned out to be indispensable. "Since we shot our plane-mounted plates at various times throughout the day," Miller concluded, "we *had* to be able to change that f-stop remotely from inside the aircraft. Flying above and below clouds makes for an enormous difference in exposure. And if you don't compensate for your exposure when you slow your camera down from twenty-four frames per

second to one frame per second you aren't going to get any picture at all. Your image is just going to be totally overexposed — a nothing-white field.”

Since much of *Firefox*'s action takes place over the glaciers and icefields of Russia and its surroundings, Eastwood had decided to utilize authentic arctic locations for a number of key live-action and effects sequences. So in May 1981, the star, selected first unit personnel, Dykstra and a small Apogee team took themselves and their equipment to the United States Air Force Base at Thule, Greenland. The Apogee members would remain at the remote Strategic Air Command installation from two to four weeks, depending upon the extent of their involvement. During the Thule shoot, the Apogee unit found itself concentrating on a number of effects sequences and techniques, not the least of which was filming the aerial background plates of snow, ice and glacier formations.

Once at Thule, the camera package was fitted into a Lear jet owned by Clay Lacy, a United Airlines pilot who joined the Apogee team at the very beginning of the Greenland shoot. Well known for using that same Lear as an equipped aerial photography platform for a number of other projects, Lacy had been also responsible for filming much of the 727/747 footage seen in United Airlines commercials. “Clay's a real artist,” Dykstra enthused, “an outstanding pilot and photographer. He piloted us through virtually every bit of sea, land mass and cloud footage you see in the film.”

Besides the Thule locations, Lacy's Lear was present at all of the various global locales needed to gather *Firefox*'s flying plates. The Thule shoot ranged over a variety of terrain — some of it beautiful, some of it bleak, all of it icy. Most of the resulting footage was held in reserve for those sections of the film where Gant flies closely by identifiable glaciers and snow fields. Lacy also flew the camera crew — for three days out of Boise, Idaho — over the Sawtooth Mountains, which doubled for the Urals in the movie. The Sawtooth plates were most spectacularly utilized in those moments when Gant, after first stealing the *Firefox*, opens up the MiG's engines “to see what this baby can do.” Two other quick, one-day plate photography flights were later taken over the Pacific Ocean when the crew returned to Los Angeles; and in July, basing out of New Orleans, Lacy and Apogee spent a week flying over the Gulf of Mexico. Primarily water and cloud plates, the New Orleans backgrounds were perhaps put to their best usage in those exhilarating shots where, moments after the actual hijack, Gant thunders through a gorgeously tinted, cumulus-cluttered dawn sky.

Clay Lacy's Lear, with an ongoing rental rate of \$ 1200 an hour, normally cruised at speeds between 250 and 300 knots. During most of the flyovers, John Dykstra occupied the copilot's seat, only giving up the position during those situations where a real copilot was required for safety reasons. At these times, Dykstra could be found sitting in the rear of the plane, closely following the cameras by means of a video monitor connected to a belly-located Astrovision camera system, which in turn was secured by a universal undercarriage that Lacy had installed in the Lear for his prior commercial work. In addition to Dykstra, a fluctuating contingent of four to six Apogee members was normally on board. “I was pretty much in charge of running the computer that was recording the external data,” said Mat Beck. “As for power, the camera controller had originally been running off a straight DC battery hookup, but Al Miller eventually rejected this supply as too troublesome. Instead, Al installed a 110 AC source in the Lear by means of an inverter, which boosted the plane's

normal 28-volt power supply up to snuff. So all we really had to do then was just plug the thing in — like plugging into a wall.

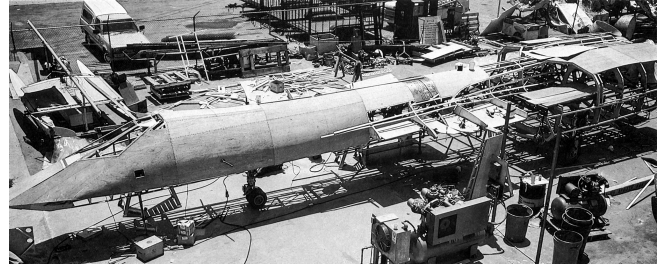
“Basically, there were three separate systems to the Lear. The INS was primarily run with the nose camera, to which had also been attached the speed changer and exposure compensator; the Astrovision camera ran as a slave to the nose camera. The nose camera was locked off and went wherever the plane was pointed. Clay’s jet already had a small nose mount for an Eclair and Arriflex, but we had to make a new nose mount from scratch because we ended up doing something that I don’t believe has ever been attempted before. We mounted a VistaVision butterfly camera with thousand-foot magazines and a flat-field 15mm Nikon lens — an extreme wide angle lens — up there in the nose of that plane. Don Trumbull adapted a set of Mitchell gun camera magazines with a special transfer box, thus allowing us to use the thousand-foot magazines. This, in turn, gave us more air time for each load, since the nose camera could only be loaded on the ground.

“Besides the nose camera, the Lear also had a side-mounted camera, and an Astrovision system with attached snorkel lens that we rented from Continental Camera. The INS could also be run through the Astrovision periscope, and we used a VistaVision butterfly mounted on the Continental system as well. Al Miller came up with a set of encoders to attach to the Astrovision system as it had the ability to pan and tilt; and as these motions were being performed, the encoders recorded those displacements as well as the INS information. Therefore, those encoders enabled us to relate all those different belly camera functions to our stage photography.”

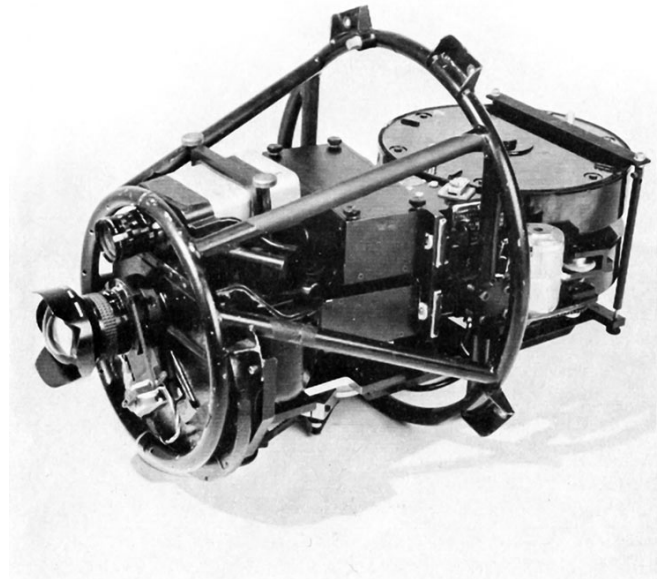
The radio-controlled Firefoxes were to be the first actual flying *models* shot for the film. “When we originally estimated our time and finances on this film,” said Grant McCune, “I figured, well, if they give me a lot of time and not a hell of a lot of money, we can make *anything* fly. So when the radio-controlled Firefoxes were brought up, I said I thought it was possible. It wasn’t a week later that I was told Malpas wanted them to be ready to go to Greenland in three weeks. They had to get up there by then, they said, or else the ice would melt. Well, this wasn’t exactly the time frame I’d had in mind, but we got going as quickly as possible. We first tried changing the way we usually cast our stage models by switching over to a carbon fiber process, one we felt would be strong enough for a flying miniature. But casting carbon fiber model molds is a pretty severe process. You end up with temperatures in the hundreds of degrees and pushing between thirty and forty thousand pounds of pressure in your casting devices to hold everything together. Anyway, it turned out that I couldn’t quite get the carbon molds to properly function in the little time that we had; so at the last minute, we changed over to straight epoxy, which is what we cast most of the models for *Firefox* from anyway.

“We eventually cranked out four radio-controlled Firefoxes. We crashed two in testing, and the second pair went to Greenland. These two were ultimately blown up for the Voskov/Gant dogfight. They were all one-twelfth scale — 63 inches long, equivalent to 63 feet. There were two basic radio-controlled Fox types — one that was a single-engine model that weighed fourteen pounds, and the other a twin-engine fifteen-pounder. From the outside, though, they were all identical in appearance.

The radio-control mechanisms themselves were provided by Kraft Systems. With the help of Jay Replogle, a local hobby store owner, and Larry Wolfe, another model pilot, McCune then installed these mechanisms. “All things considered, the radio-controlled Firefoxes performed quite well in their limited life span. The scenes we wanted to capture of them in Greenland related to Gant’s refueling sequence on the ice floe — landings, taxiings and takeoffs on the ice. Since the wheels would always



For live-action scenes requiring actors in close proximity to the Firefox, a full-size mockup was constructed from aluminum, steel, plywood and fiberglass. The canopy, ailerons, flaps and other movable sections of the plane were fully articulated, and a built-in Volkswagen engine allowed the craft to taxi up to thirty miles per hour.



For sky and cloud plate photography, a VistaVision camera — complete with inertial navigation system to record motion control data for later use on stage — was especially configured to fit inside the nose compartment of a Lear jet.



John Dykstra and pyrotechnician Richie Helmer observe insert photography of the MiG's engines firing up. The effect was achieved by installing gas-fed hot-air balloon heaters in the engine pods.



Looking down on the full-size Firefox. A hangar at the Van Nuys Airport doubled as the home base and development center for the Soviet super-secret warplane.



For scenes involving the aircraft's required pitstop on an arctic ice floe, the full-size mockup was transported to Montana. A camera crew dollies past the mobile mockup as it taxis through the hard-packed snow.



The Firefox nestled up to a submarine conning tower at the clandestine refueling point.

be in use during these shots we'd built the radio-controlled Foxes with no retractable landing gear. Jay and Larry were flown up to Greenland to operate the models, because they were quite experienced at radio-control. We succeeded in getting the planes to fly from the runway at Thule Air Base. However, when we took them out to the ice floe, the rough surface texture of the ice, and gusting winds, made it impossible to fly the models — or even to shoot them taxiing, due to wiggle." Consequently, there is no footage of a radio-controlled flying Firefox in the film.

More successful by far was the *full-scale Firefox*, an Apogee venture which leapfrogged out of the realm of model building into full-size reality. Lasker and Wellman's script clearly indicated a number of crucial scenes calling for Gant to be shown inside the warplane. Among these were the live-action shots of the theft of the plane from its Russian hangar — actually the Air National Guard facility at the Van Nuys Airport — and the *Firefox* refueling rendezvous, eventually lensed in

Montana. Grant McCune was put in charge of the full-scale *Firefox*'s main and outer structural design, as well as manufacturing the craft's "skin" and designing the overall ship so it could be modularly broken down for easy transport to its various needed locations. Assisting McCune was Bill Shourt, *Firefox*'s mechanical special effects chief, who would be responsible for the plane's inner mechanics.

An impressive blend of model and mechanics, the full-scale *Firefox* did just about everything but fly. "It had an electrically run canopy, operating ailerons, rudders, flaps, and spoilers on the wings, air brakes on the top of the fuselage, and canards," McCune outlined. "Its power system was a chain-driven 1600 Volkswagen engine, with an automatic transmission that drove the main gear. Because of its motor/gearing potentials, it had the capability of taxiing up to about thirty miles per hour. The suggested size of the Fox in the script was between 63 and 65 feet in length. As it turned out, it was actually 61½ feet long by 42 feet across, wing to wing. I cheated some on the wing tip to keep it from flopping around too much. And that plane was seventeen feet high. When it was broken down for transport, the main body stayed in a piece thirteen feet wide by 61½ feet long by nine feet tall. Then the two outer sections of the wings came off — in two pieces each — along with the wing tips, sponsons and canards."

The main structural component of the full-size *Firefox* — around which everything else was built — was a forty-foot steel radio tower running the length of the plane. Across the "back" of this tower was a large aluminum I-beam, from which descended the VW power train. Bill Shourt then installed the landing gear, stripped from an old F-4 Phantom jet loaned by the Air Force. "Basically, the construction of the full Fox all hinged around that steel frame. To fabricate the shape, we took a foam model out of the 63-inch model mold, sliced it up into fifteen sections and projected those onto a wall. We then hung up pieces of birch plywood and sawed out all of the bulkheads based on those projections, attaching them to the plane's frame. Then we went about the job of stringing and skinning the plane, just as you'd do with a boat. The whole nose section was fiberglass. Since that was a part of the plane that was constantly close to the camera, it had to have a relatively nice finish on it. The wings were mostly thin plywood, with their leading edges carved out of surfboard foam and glassed over."

Normally, there were five people hidden around inside the ship to operate it. The "driver" actually sat within the body of the plane, concealed by the fuselage and located behind the ship's middle vent. Behind this driver was another seat for the person who ran the air-powered mechanisms controlling the spoilers, flaps and air brakes. Quite near the tail section were two more hidden operators, both responsible for controlling twin hot-air balloon heaters. These had been installed in the engine vents to suggest the full-size *Firefox*'s deep blue after-thrusters, and were fired up solely for night shots. The massive heaters were the largest commercially available, putting out millions of BTUs, and their gas-fed flames were blown away from the craft by large industrial fans mounted within the engine housings. "With four guys in the plane essentially blind," said McCune, "the fifth man, sitting in the cockpit, was their eyes to the outer world. Most of the time, Clint or I sat up there with a costume and helmet on and guided everything by an in-plane radio."

With the hangar hijacking footage secure, finding live-action locales for the full-scale *Firefox*'s refueling scenes became a problem. The original plan had been to shoot the ice floe sequences not in the arctic, but in White Sands, New Mexico, where the sand is so brilliantly white that it could

pass as snow on film. “We got all prepared to go there,” said Grant McCune, “but then, because of the possible Shuttle landings, they switched over to the Bonneville salt flats. But it rained, and flooded Bonneville for the entire winter. So they carted it out to Cutbank, Montana. Unfortunately, it never snowed enough in Cutbank. So they shipped the plane over to Glasgow, Montana, where they were finally able to get their shots of the full Fox, the full-scale submarine conning tower and full-size base camp. Then they brought the big Firefox back to Los Angeles.”

But the full-scale Firefox stories weren’t finished. “We kept the big ship in an old hangar out at the Van Nuys Airport,” McCune recalled. “On a night shoot, we were running it out of the hangar to the runway, and during one of those runs it just went totally out of control. One of the drive chains had broken; and unfortunately, the brakes were above the chains and drive system. So when the chain went, the brake on that wheel went with it. Consequently, giving it gas turned you left and braking turned you right. Anyway, we spun around out of control and went off the main runway. Fortunately, we didn’t hit anything; but we did run into a small gully, and when we tried to pull the plane out, the front landing gear collapsed.”

Although Eastwood had decided that Greenland and Montana would adequately suggest Russia for most of the ice and snow shots, much of the film’s action also takes place in and around Moscow. Since the Soviet capital was understandably off-limits, Vienna was consequently selected as an appropriate stand-in, with many of the street and airport scenes being filmed there.

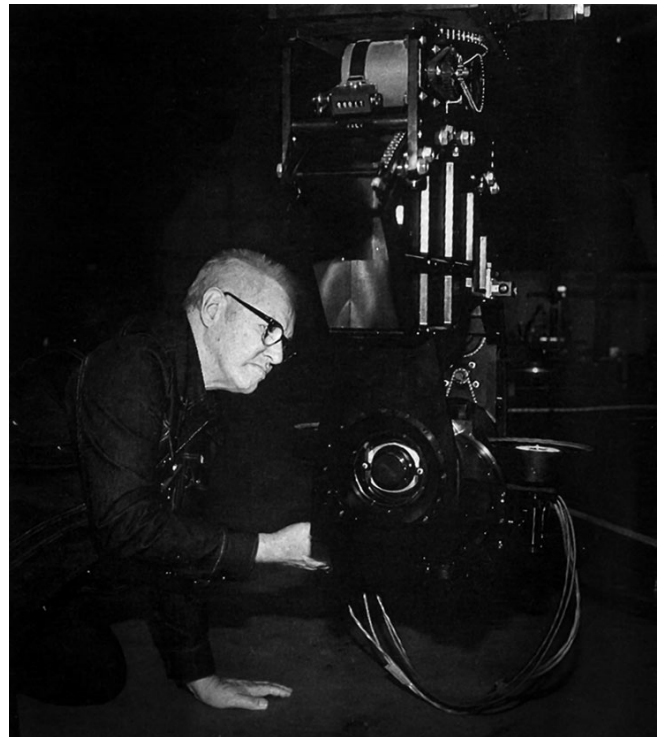
Two other Austrian locales were then chosen as the setting for important plot points. The hillside where Gant’s Russian coconspirator Pavel Upensky lies dying was filmed at Weisskirchen, while the Soviet runway where both Gant and his pursuer take off in their respective Firefoxes was actually filmed at the Austrian Air force base of Zeltweg. Significantly, these Austrian locations served as backdrops for another technological development — Apogee’s field motion control unit.

“For a long time we’d been tossing around the notion of having a light, portable motion control unit which we could take out on locations,” said Mat Beck. “Firefox was finally the project that utilized that system. The unit we came up with — which we dubbed the field control system — is in fact a full-fledged motion control unit. But because it’s of a newer generation, most of its functions are put into a computer rather than hard-wire logic. We based this system on a slightly modified Apple II, one whose memory we’d increased in excess of 64K. At its simplest, the field unit consists of the Apple, an interface box that talks to the outside world, and a nodal point camera head with DC servomotors on it. There are no tracks involved. Wherever you set down the sticks, you then just hook everything up and record strict pan and tilt shots. Additionally — and depending on the application — we had various kinds of interface boxes to play around with. The standard one was our field system interface, which allowed us to control eight channels of movement. Within that box, we also had installed the capacity to drive four motors. It was totally self-contained. Further, if there were any problems in using the DC servos on the unit, you could redirect the outputs to control separate stepping motor drivers. We could put any kind of camera on the nodal head; but for most of the field shots in this film, we used a full-speed VistaVision.”

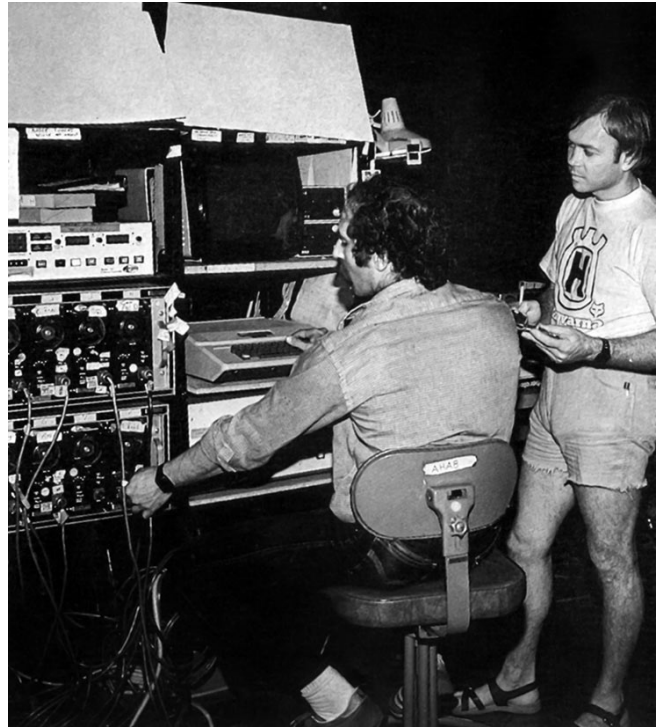
Beck operated the field motion control unit for the shots at both Zeltweg and Weisskirchen — securing specific moving background plates, which would later be composited to the stage model Firefoxes. “The Weisskirchen sequence was filmed at speed, because we had a live actor there,” said

Beck. “The shot lasted all of about six seconds. The plot had Pavel falling onto the hillside, dying, when he hears the sound of the *Firefox* overhead. He looks up and the plane flies over him. To take that, we did a pan with the field unit, taking in the hills and the sky over the actor. But it wasn’t easy. There was some pressure involved. We had been committed to shooting this sequence at sunset — in one day — and there we were on a hill with an internationally known star and large crew staring at us. We’d had to get up there and be ready to go long before the sunset itself, because we literally only had a time window of about twenty minutes to get the footage. Once the sun set, that was it. Things had to work; we had no choice. We did about four takes before we were satisfied. Then, when we got back to Apogee, I shot a 21-inch stage *Firefox* model using the same Weisskirchen data for the later composite.”

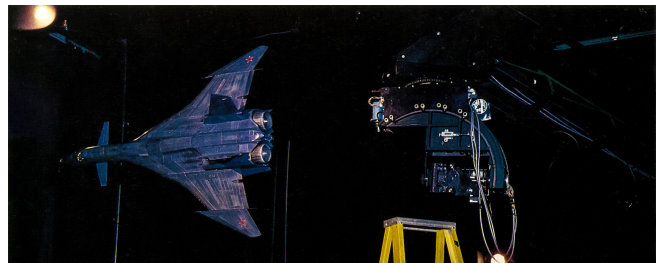
The most spectacular use of the field system involved Gant’s sunrise takeoff in the stolen *Firefox* from the secret Soviet



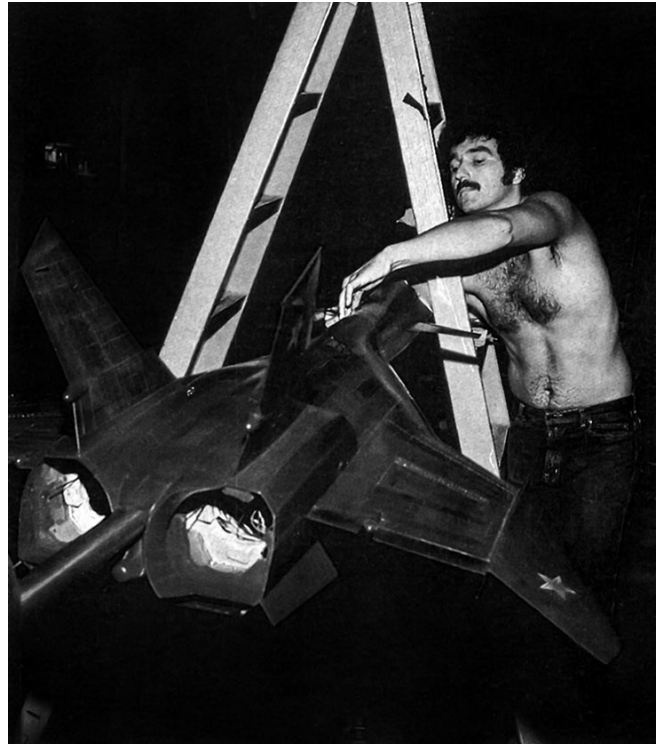
Don Trumbull inspects his custom VistaVision Butterflex — a newly-designed mirror-reflex motion control system used extensively in Firefox.



Cameraman Mat Beck and assistant Richard Haas at the motion control console.



A 63-inch stage model being photographed by Apogee's Vistaflex camera system.



Modelmaker Pat McClung manually positions one of the aircraft's canards.



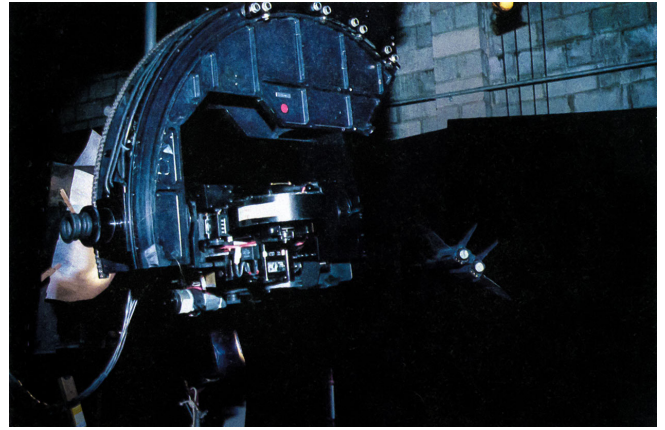
Mat Beck adjusts a lens setting on the Vistaflex, in preparation for a shot featuring one of the smaller, 21-inch models.

installation at which it has been based. This runway ascension called for both panning and tilting field control plates, plus later compositing with another 21-inch scale model. "We did work a bit harder on the takeoff sequence," said Beck, "because if people didn't buy it, they weren't going to buy any of the other suspense in the rest of the film," The *Firefox* runway takeoffs were shot at a variety of frame rates, with the majority of the material falling between twelve and twenty-four frames per second. "Time-wise it was pretty bizarre. For that first takeoff we were shooting at sunrise *and* sunset. We'd get up at three o'clock, meet at four and leave, set up to shoot the sunrise and then go back home to sleep. It was really disorienting, like living two days in one." The Zeltweg sunrise/sunset field control schedule had been decided upon to give the Apogee crew maximum coverage of Gant's takeoff. Additional full-daylight shots were also taken of Voskov's later departure from the same strip.

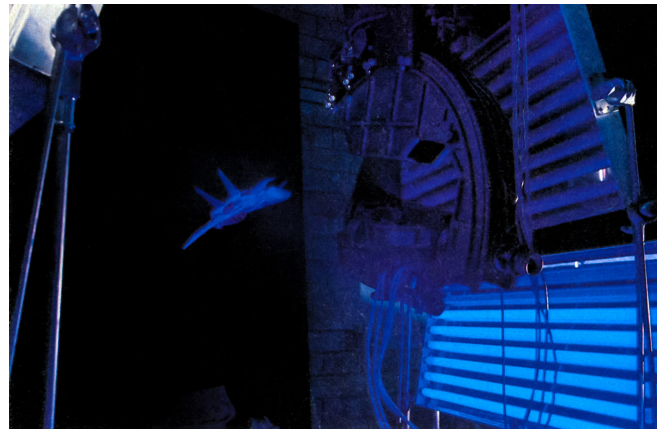
Back at Apogee, Gant's takeoff field unit plates were matched up with the model footage shot with the Butterflex, or reflex butterfly motion control rig. It soon became apparent that, in this particular instance, a motion control lighting decision was in order. "During Clint's first takeoff," Beck explained, "the valley was very dark and the sky above was light, with dawn breaking. So as the plane lifted up over the valley, it would naturally pick up reflected sunlight. We suggested this on stage by plotting a certain angle relative to the hillside on the plate; and then, when the stage model had reached that point, we turned on a kicker. This way, we had our light being bounced off the sunside of the ship."

Additional motion control passes were required for the plane's landing lights and engine exhausts.

"The composite exhausts were one of my pride and joys," Beck said. "To get the engine flame effects while the miniature took off, Grant McCune came up with a matching pair of one-inch diameter butane burners. Mark Cane, in the machine shop, made up a mounting rig for them. We also came up with a new model mount that securely tied down the miniature plane. The model ship went into a right angle and was tightened onto a rod running into the model mover. To set up the engine pass, we simply undid the small rod the plane was mounted on, slipped it out and slipped in Grant and



The Butterflex closes in on one of the 21-inch models — used primarily in those scenes requiring the Firefox to cover considerable distances at great speeds.



To facilitate the photography of troublesome shiny objects, and eliminate several steps in optical, Jon Erland developed the reverse bluescreen process as an alternative to traditional bluescreen model photography. Completed models are coated with a transparent lacquer containing a phosphor which is invisible in the absence of ultraviolet light. The model can thus be lit normally for the primary "beauty" pass, but then itself becomes an illuminated source when lit solely with ultraviolet for the subsequent matte pass. As a result, a burned-out image area corresponding to the shape of the model can be produced without the need for any sort of blue-backing.

Mark's motor mount. We then had a couple of registration pins nearby on a C-stand, which we tightened down so that everything correctly lined up — at which point we made the engine pass. There was a bit of sweat and tears involved here, because we only had a couple of shots that involved this butane mount, and therefore we couldn't afford a super-duper registration system. But it all worked out fine."

"We had two stages at Apogee shooting the *Firefox* miniatures," said John Sullivan, "and that required two motion control boom rigs. One held a Vistaflex camera and the other contained the reflex butterfly. On both of these stages, we could lay up to five sixteen-foot sections of track for the rigs to travel on; but the most track that we could practically allocate to any one stage at any one time was sixty-four feet.

"The Stage I rig was the reflexed VistaVision butterfly.

Don Trumbull had designed the conversion some time ago and we'd been working on it since then; but it was finally completed for our work for this show. The advantage of having a mirror-reflex motion system is obvious. In between each lighting setup on the same model, we can look through the camera to see exactly how the camera perceives that miniature — all without having to unload the camera and put in a viewing tube. We can also make lighting changes between passes and be sure our flags aren't seen by the camera.

"On Stage 2, we use a Vistaflex camera, which does require a viewing tube, although we have plans to reflex it in the future. The Vistaflex was designed and built at Apogee around an optical printer shuttle movement. This gives us the ability to use the camera with interchangeable 4-perf standard or 8-perf VistaVision formats. The camera can run up to eight frames per second maximum; and one of its advantages is that it's small in size, which allows us to move much closer to the model. The Vistaflex was assigned to the 63-inch *Firefox*. We anticipated that it would be impossible — even using all sixty-four feet of track and a 15mm lens — to achieve the tremendous size changes needed to give this model its Mach 5 flight. So for all the fast-moving shots with great size change, we used a smaller 21-inch model — leaving Stage 2 the larger model for detailed closeups and beauty shots."

In order to generate the proper material needed to composite miniatures and plates, the usual approach is to work with either bluescreen or frontlight/backlight traveling matte systems. *Firefox*, however, used bluescreen only in the early photography, primarily because of its supplantation by yet another Apogee technical innovation.

Some bluescreen work does remain in the final print, primarily in a few cloud shots and notably during the shot where the two aircraft drift in from left of screen towards the camera. One ship then exits right of screen as the second fires a pair of missiles after it. Bluescreen was also used in a live-action situation involving the Tupelov 134 — a Soviet commercial airliner which is virtually a carbon copy of the Boeing 727. In the film, Gant nearly collides with the Tupelov in an effort to throw the Soviets off his trail during the aerial chase sequence. To portray the Russian flight crew looking out of their cockpit at Gant's retreating *Firefox* — another 21-inch stage model — Apogee gained permission to shoot inside a Western Airlines 727 flight simulator located near Los Angeles International Airport. In preparing to shoot through the simulator's windows, the Apogee crew placed a frontlit blue screen outside the cockpit — aided by the first unit crew, which helped set up

and then stood by to shoot additional coverage once the bluescreen work was completed. These shots were later combined with composite window imagery of the *Firefox* diving out of the clouds.

The decision to abandon bluescreen for *Firefox* was agreed to early on in the effects shoot, primarily because of Eastwood's fondness for the shiny airplane. "Rather than just go with a flat-black plane," said Roger Dorney, "which would have reflected a holdout, outer space type matte, Eastwood wanted to add character and beauty to the *Firefox*. Therefore, the plane, in his opinion, had to be shiny and show some kind of individuality. Optically speaking, this created quite a problem. The difficulty in shooting conventional bluescreen is that the light from a transmission or frontlit blue screen will reflect back onto that shiny surface; it just wants to wrap in on it. It's very difficult to pull a clean matte in this situation because you can bet that the blue spill has created a hole in your image. This is exactly the problem we had with our early *Firefox* bluescreen material. The wings on the planes started disappearing very quickly as they got close to the blue screen; and as they pulled away, the wings *also* disappeared because they were overwhelmed by the blue."

A number of different techniques were initially employed to overcome the spill problems, including one method by Doug Smith and John Sullivan which depended on falsifying the color records achieved during a bluescreen pass. By lighting the *Firefox* models red, or by burning the models out in front of the blue screen by overlighting them with white light, the effects cameramen hoped to give optical supervisor Roger Dorney a number of different elements from which he could eventually force an adequate matte. Some of these alternatives were successful; but like the straight bluescreen approach, they were also tedious and erratic, sometimes taking up to four hours to complete a single acceptable shot which, when repeated, would be optically worthless the second time around. The ultimate answer to the spill problem lay in a totally different direction and technique — the UV or "reverse bluescreen" process.

"Jon Erland is our resident scientist and R&D expert," Sullivan continued. "He gets into a lot of projects and ideas. The ultraviolet or reverse bluescreen system was something he'd been developing for a while, and this idea worked out tremendously. Basically, the UV process lets us pull a matte off a shiny object with absolutely no screen of any kind behind it; and in addition, that shiny object can be any color at all — black, silver or even gold. The UV system allows the model to generate its own matte.

"We would first treat the *Firefox* miniatures with a transparent coating containing a phosphor that could be excited by a set of special fluorescent UV lights, while being invisible in white light. Then we would plug up any holes or vents in the model; otherwise, we would get small shadows on the model, resulting in holes in the final matte. Surrounding the model with the UV light source, we'd then light the stage, and the miniature would glow, generating its own matte. Occasionally, we would also have to use some dichroics to force the phosphorescence we'd treated on this model into a range of color that would make it easier for the optical department to pull their mattes. The reverse blue-screen process saved us an enormous amount of time. We could shoot our beauty pass — which was lighting the fox with all the glints Clint wanted on the ship — and then go back for the UV pass. And that would be it, unless it was a shot requiring another pass — an engine effect, say. So we went from shooting many passes in the conventional bluescreen way to only shooting two with the reverse blue. And Roger got his mattes a lot quicker and tighter this way. It was a tremendous time saver."

Unlike conventional bluescreen, the reverse bluescreen process does require an accurate and sophisticated motion control system, as it is dependent on the ability to make multiple passes in perfect registration. Also, the inaugural use of the process was put to a severe test on *Firefox* in that the aircraft's black body tended to absorb much of the light given off by the phosphor coating. "We overcame this," Roger Dorney explained, "by pumping a lot of ultra-violet light on the miniatures and by the use of the dichroics. After shooting a reverse blue pass, we take the original negative and, on high-contrast film — which in Apogee's case is Kodak 5369 — we make a burn-in matte. During the actual photography, the UV is radiating the light and spreading the image, so we have to print the original burn-in matte heavily in the black area, shrinking the matte down to fit the object itself. Usually, though, this problem was minimal. If the reverse blue is shot with the right amount of light, the burn-in comes back just fine — nice and heavy, and pinched into the ship a bit. The next step is to print that burn-in matte back to make the holdout matte. To do this, the burn-in would either be inked or garbaged off to lose some of that extraneous stage rigging. These two units are then used to composite the image, rather than going another two generations down the line as in conventional bluescreen. So you not only save steps, but since you're closer to your original photography, you also end up with a much higher generational quality."

Beside the technical challenges, *Firefox* also held a certain personal appeal to key members of the Apogee team. Dykstra, Shepherd and McCune all are licensed pilots, part owners in a Helio Courier private plane based at the Van Nuys Airport. With this aeronautical background in mind, and given the nature of the script, an inevitable question arose — how does one visually determine the aerial movements of a nonexistent airplane?

"The hard part of that question lay in deciding whether the *Firefox* audience would be composed of pilots or people used to seeing *World War II* dogfight footage," explained McCune. "Most everyone has seen a film with a staggered line of Corsairs peeling gracefully out of formation, plane after plane. Well, we all knew here that those movements were unacceptable to the design of the *Firefox*. So one night, John and I were sitting around jawing with an ex-Vietnam pilot named Duncan Wilmore — who was our Air force public relations officer on this film — and I asked him, 'What does it *really* feel like to be flying one of these 60,000-pound Mach 2 giants?' Wilmore said that when you really do have a missile on your tail in one of these fighter jets, or if you're trying to evade flak or someone's coming after you in another jet, you're just constantly cramming the throttle from full to nothing, grabbing onto your stick for dear life and mixing it. You're also being thrown around by six or seven Gs in the cockpit. Your harness is holding you reasonably upright, but your eyeballs are rattling in their sockets. Most of your senses have left you, and you're playing in another world. Dow, all this may look coherent to someone watching the ship from the outside, but inside it's anything *but* coherent. The question is, how do you invest the pilot's subjective craziness to an audience? Well, obviously you shouldn't even want to. An audience is used to apprehending flying as the beautiful gliding movements they can see a 747 doing during a television commercial."

"Eventually we decided," said Dykstra, "that the more articulate and graceful the *Firefox* move — even under the auspices of really having to crank the plane around in such sequences as the dogfight — then the better it would look to the audience in general. I also tried to stay away from getting the ship to fly directly over the camera three inches away from the lens. I felt we'd already done too much of that *Star Wars* stuff in any number of other projects. An aerial ballet quality was

much more important to me, with the camera constantly moving in counterpoint to the cloud plates. That was no mean feat, I can tell you. When you're working with the blackness of space, and stars, it's a piece of cake compared to compositing in real atmosphere."

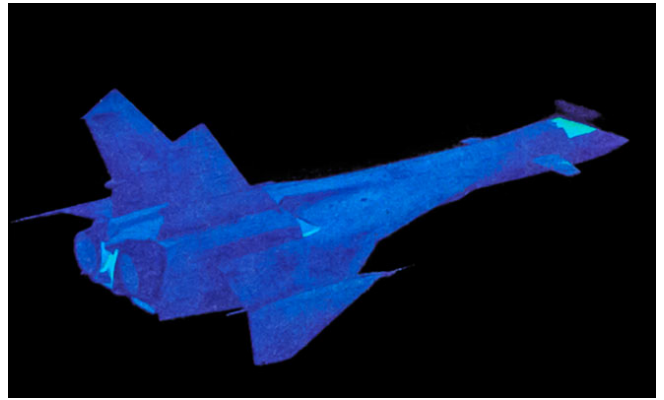
The first step in selling the *Firefox*'s aerial movements lay in converting the data collected from the INS system into usable stage information. "There was a fair amount of trigonometry involved in that," Beck recalled, "trying to figure out how to convert raw platform data into actual angular lens displacements. for instance, if the camera was pointed exactly straight ahead on the plane, then if the plane rolled five degrees, the camera did the same and everything would be in sync. But what happens — especially through the Astrovision system — if the camera is not pointed straight ahead, but rather pointed 37 degrees forward of straight back and downward at an angle of 40 degrees? What does five degrees of roll mean then? Not to mention the problem of the focal length of the lens, which is another variable?

"An additional complication was that with two cameras running at the same time at different speeds, one camera always had frame-to-frame data and the other, running at a slightly different rate, would demand extra interpolation. We finally solved all this through the use of hard, hard math. Al Miller and I worked on it, as well as Susan Sitnek. Susan did an awful lot of good work, and really made the programs which allowed our people to convert that raw information into viable motion control patterns."

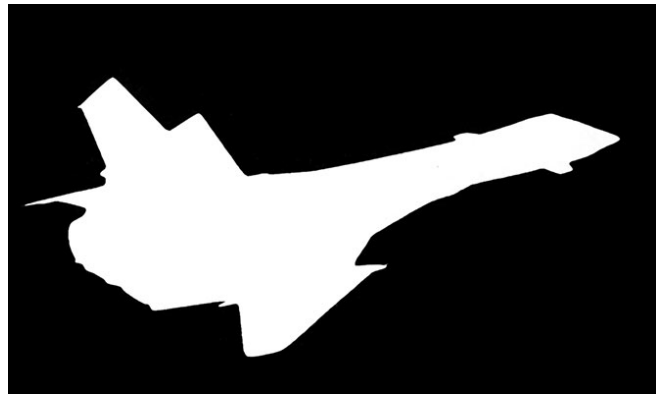
Some of the equations built up from the INS data gained their own distinct identities. Dykstra's theorems concerning the actual performance of a real jet involved fast and full throttle acceleration. But as Al Miller recalled, matching theory to trigonometry resulted in strange geometry. "Our hypothetical acceleration curves became very weird looking. We'd worked out the fact that when a goosed jet reaches top-end speed, friction and other variables take over and acceleration falls, finally tails off. Because of this, we ended up with speed curves that were really skinny on one end, fat in the middle, and skinny on the other end. They began to look like something Monty Python would dream up; and we did, in fact, get kind of whimsical by



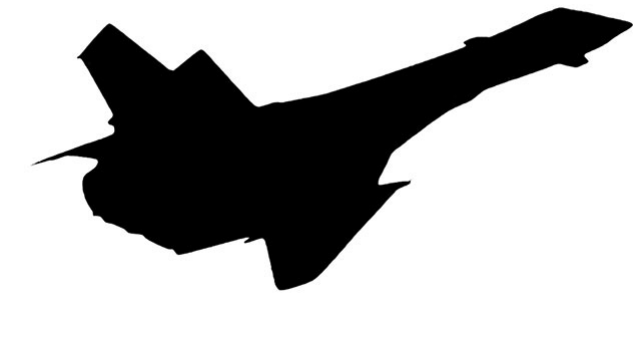
Basic film steps for Apogee's reverse bluescreen process: 1) frontlit "beauty" pass utilizing incandescent lighting, with desired glints and reflections: 2) identical matte pass of phosphored model irradiated with ultraviolet light: 3) burn-in matte generated optically from matte pass; 4) holdout matte similarly generated: 5) background plate bipacked over holdout matte: 6) final composite.



Basic film steps for Apogee's reverse bluescreen process: 1) frontlit "beauty" pass utilizing incandescent lighting, with desired glints and reflections: 2) identical matte pass of phosphored model irradiated with ultraviolet light: 3) burn-in matte generated optically from matte pass; 4) holdout matte similarly generated: 5) background plate bipacked over holdout matte: 6) final composite.



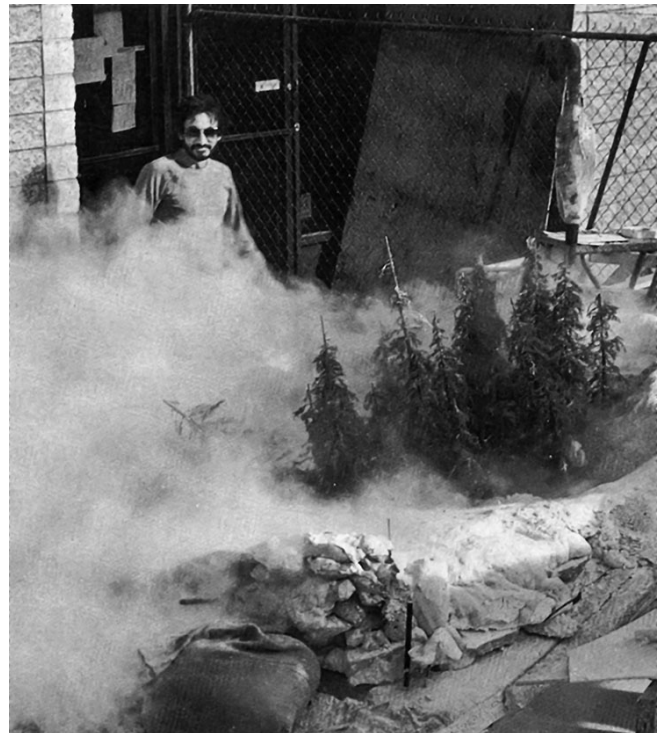
Basic film steps for Apogee's reverse bluescreen process: 1) frontlit "beauty" pass utilizing incandescent lighting, with desired glints and reflections: 2) identical matte pass of phosphored model irradiated with ultraviolet light: 3) burn-in matte generated optically from matte pass; 4) holdout matte similarly generated: 5) background plate bipacked over holdout matte: 6) final composite.



Basic film steps for Apogee's reversed bluescreen process: 1) frontlit 'Beauty' pass utilizing incandescent lighting, with desired glints and reflections: 2) identical matte pass of phosphored model irradiated with ultraviolet light: 3) burn-in matte generated optically from matte pass; 4) holdout matte similarly generated: 5) background plate bipacked over holdout matte: 6) final composite.



Dennis Dorney and Doug Smith film sonic shock waves ripping through a miniature mountain range.



For a close shot, miniature trees were arranged in forced perspective and covered with microballoons to simulate snow. A large air cannon provided the actual explosive force.



Gant's Firefox skims over the Urals, leaving a path of destruction. Single-frame rotoscope mattes were introduced to suggest that the plane passed behind some of the larger foreground trees.

dubbing those graphs dinosaur curves — one was called brontosaurus, one pterodactyl, and so on. What was even funnier is that those dinosaur curves were, in fact, the ones we finally tried out and used.”

However, even with the reliable dinosaur curves, there remained the problem of compositing the plane and cloud plates — both of which were usually moving at different rates — in such a manner so as not to give the impression that the miniature ships were simply “floating” on the backgrounds. Part of this problem was solved by Dykstra’s assumption that the cameras in the aircraft were far enough away from the background that one could assume the background to be at infinity. “If the plane bounces up and down,” said Mat Beck, “you don’t really see the horizon move. The horizon moves because of roll or pitch changes of the camera platform. Assume you wanted the model you were photographing to just sit there on the horizon. Well, when you fed the converted INS data into the motion control system, the motion control camera would photograph the model so that it moved up and down in the frame. When this was added to the background, both the plane and the background would move up and down together — and your imagination cancels out the bounce.”

After hijacking the *Firefox* from its secret Soviet base, Gant delightedly puts the plane through a number of maneuvers, including opening up the throttle, full bore. In a vertigo-inducing POV shot, Gant then guides the plane directly towards the Sawtooth “Urals” in ever-increasing speed, an effect obtained by the speed-ramping system and some judicious skip-framing done by Apogee’s optical department. However, when the *Firefox*’s shock wave or “sonic footprint” then blasts tons of pines and snow away from the face of a peak, the effect was done entirely through miniatures.

Grant McCune and the model department first began their depiction of the model Urals by ransacking Apogee’s storage room. “We had four large ten-foot by twelve-foot tables left over from *Avalanche Express*,” McCune recalled, “and they already had large foam mountains on them that we’d constructed for that film. They were also studded with some very convincing miniature boulders, which we’d built up from castings of lumps of anthracite coal that were then cast back in polyethylene. These ‘rocks’ were then stuck on our mountains, painted, and dressed with snow. For *Firefox* we simply cut up and rearranged these mountains, laying them down in different places around the tables, which then gave me a nice foam bed to bury our miniature trees in. The trees themselves were arranged in a forced perspective, and the tallest trees were about thirty inches, while the smallest were toothpick size. The entire set was covered with glass microballoons to suggest snow. We took these tables out into our parking lot, waited for the right lighting conditions,

and shot our footage. For the shock wave effect, we aimed a huge air cannon either across or towards the camera, and then let it rip apart the snow and trees.”

The miniature trees on the tabletop Urals set were suggested through a variety of techniques. Cut and patterned air conditioning filters were used for the small trees farthest from the camera, while the medium-sized ones were built up from air ferns. The largest trees, those closest to the camera, were assembled from actual juniper branches. “If you look at the junipers out in front of the shop,” said McCune, “you won’t find a one that has much of anything left on it. Most people know how we miniaturists will scavenge prepackaged models — and most people know it’s called kit-bashing. Well, for *Firefox* we came up with a new buzz word — nature-bashing!”

After his Urals joy-ride Gant quickly dispatches a Russian reconnaissance plane called a Badger — a fifteen-inch-long vacuformed styrene model shot for a quick double exposure explosion — before heading out over the Barents Sea. Flying low, right above the water, the *Firefox*’s sonic footprint leaves behind an incredible trail of cannonading explosions — twin trails of huge waterspouts that follow behind the plane. Capturing these watery shock effects began with a January 1982 trip to Catalina Island by the Apogee effects team and Eastwood himself, who registered at the island’s Pavilion Lodge under the name “Mitchell Gant.”

Apogee’s resident pyrotechnician, Richard Helmer, had brought huge spools of 400-grain primer cord to the Catalina shoot. Normally a timing and not a concussive material, Helmer nevertheless tied 400-foot strands of the material together with a sequential twenty-five millisecond delay set in between each “charge.” These strands were then tied off to and towed behind two shore boats which steamed off into the waters around the island. A large fishing trawler was then used as Apogee’s camera platform, carrying a Hill Productions’ 4-perf Photosonics, two Mitchell 4-perfs and one high-speed VistaVision camera. At Dykstra’s command, the cameras were brought to speed and the primer cord charges were detonated. Two basic variations on the explosions — each over ten feet high — were then recorded. One had the explosions sequentially racing towards camera, and another was a side-to-side, parallel angle.

An interesting optical addition to these explosions — besides the composited stage model — was the watery spume that races along the footprint’s path, a fine spray greatly enhancing the reality of the effect, “We have a large rolling road or conveyor belt here at Apogee,” said McCune, “which is four feet wide and about twenty feet long. At one end of this, we affixed a box which was slotted underneath and allowed the road to pass through it. Then, into that box, we could bleed liquid nitrogen. The stage crew set up this entire rig, covered the box with black velvet, lit it very carefully and then started the conveyor belt. The liquid nitrogen passed out of the slot onto the rolling road in a V-shape. When filmed rolling, the nitrogen would curl up and around and do all sorts of nice things. This was then DX’d over the water footage, making it appear as if the *Firefox*’s shock wave was not only setting off these huge explosions, but also creating a fine mist over the ocean.”

During Gant’s flight from the Russians, he also encounters a number of Soviet helicopters — all miniatures. In fact, aside from the *Jolly Green Giant* employed in the opening moments of the film, every helicopter used in *Firefox* was a radio-controlled miniature. “The Russian copters were built on a one-eighth scale,” said Grant McCune, “and were about five-and-a-half feet long. We built three complete versions, and set aside two more extra copter bodies

for explosions and standby work. Actually, those copters went through a radical design history. The original storyboards indicated Russian Kamov helicopters, which have contra-rotating twin blades and no tail rotors. But there are no miniatures or models made to do that. So we got Clint's permission to change the Kamov into a Mil-24, which is a Soviet land-based assault chopper. We decided on that specific variety because we could then take existing model kits of a miniature radio-controlled helicopter — the Bell 222 — and produce our own version of the Mil-24. All we really did was rearrange the Bell's tail boom a bit, change the rotor location, cut out the front end and make our own Mil-24 front end mold for that section. We then put some wings and rocket pods on it, and wound up with quickly produced helicopter bodies. Like the radio-controlled Firefoxes, we had to have the radio-controlled helicopters ready for the Greenland shoot in a short period of time." With their delivery date met, McCune sent two of these model choppers to Greenland along with radio-control operators John Simone (a San Diego model helicopter producer) and David Nieman (a model helicopter pilot and designer from England).

The miniature Greenland copters were used for the sequence during which the Russians, having just missed Gant's takeoff from the ice floe, hover over the American base camp which is actually a disguised refueling station. Ground-controlled by Nieman and Simone, the two model copters were photographed over the ice from a Bell Jet Ranger piloted by Jim Gavin. "It was quite a scene to have two miniatures and one real helicopter all flying around together," said McCune. In John Dykstra's estimation the Greenland radio-controlled choppers operated "flawlessly," and the taken footage is indeed the most convincing live-action model sequence in the film.

Radio-controlled copters were also filmed at Catalina Island during the same expedition that produced the watery shock wave effects. Unlike the Greenland choppers, which survived their scenes in one piece, the Catalina models were to be exploded for that sequence when Gant passes over the Russian missile cruiser, *Riga*. One of the ship's onboard helicopters is blown out of the air by a *Firefox* missile; and the other, just taking off from the ship's helicopter landing pad, is caught in the MiG-31's shock wave, thrown on its side, and destroyed when its whirling blades strike the deck.

The first, airborne copter explosion was filmed about twenty feet in the air just off the rocky surface of Catalina's Pebbly Beach. Three cameras were set up on the shoreline to record the shot. These included a high-speed VistaVision, a 350 frame-per-second 4E camera maintained and operated by the late Bruce Hill, and a standard full-speed VistaVision camera. The three-camera setup was deemed necessary because of the nature of the shot. Since the model would be detonated, this was a one-take situation, and optimum coverage of the explosion was crucial.

The *Riga* landing pad explosion was filmed over a two-day period, just off Avalon Bay, on a miniature helicopter flight deck that had been securely attached to and built up from the fantail of a rented sixty-foot fishing trawler. "Most American destroyers are now equipped with these large helicopter landing pads," said McCune. "So the Navy allowed us to photograph the USS Fox, and then we constructed the sixteen-by-eight-foot model in our shop."

Both of the Catalina copter explosions were triggered via radio signal by David Nieman, who had been flown back from England to again control the craft while in flight. To enhance the explosions' realism, Richie Helmer had packed the miniature helicopters with various explosive charges, timing devices and lots of model mulch. Helmer then scored the chopper cockpits until the material in that

area was very thin and fragile. When Nieman tripped the explosions, the weakened cockpits effectively blew away at the same time the model mulch burst out of the main fuselage, giving the impression that the helicopter's engines had been ripped from the burning chopper as well.

"Although the Greenland copters worked perfectly," said McCune, "the Catalina shoot was something of a headache. It took us most of the day to get the Pebbly Beach footage in the can, because the first chopper that we lifted off the beach decided to immediately set itself down again — hard. That caused some damage, and our subsequent efforts to get it in the air kept having problems, too; so we spent all of the morning switching around bodies and motors on those things before we finally had one in the air and blown." The *Riga* landing pad crash was not without its problems, either. "We had to shoot that three different times. First, we blew two radio-controlled choppers on the back of the trawler; but we weren't totally satisfied with the results. So we built another, electric-powered helicopter and shot that one back here in our parking lot. That model rose up off the deck by means of a threaded shaft that was attached to the bottom of the chopper. This electric copter was exclusively used in a few shots where the camera was pointed straight down on it and the landing pad, obviating the need to show an ocean or sky around it." The final sequence was comprised of bits and pieces from both shootings.

Although Gant has successfully destroyed the helicopters, he is unaware that he is now being pursued by a second *Firefox*, the only other operational model of the MiG-31 and one that was to have been sabotaged in the hangar fire. Guided by Voskov, the Soviet's premier test pilot, the second *Firefox* refuels in mid-air during a lull in the chase by linking up with a flying gas station — a Russian "Bear" aircraft.

"The *Bear* was a seventy-inch model we rented from Greg Jein, who had purchased it from M-G-M," McCune said. "It was originally used in *Ice Station Zebra*. However, we repainted it and took the old-style propellers off, replacing them with newer,



The Soviet assault helicopters which circle the American base camp moments after Gant's departure were actually large-scale radio-controlled miniatures — about five-and-a-half feet long.



The high-flying Mil-24 choppers — modified from existing radio-controlled model kits — were piloted remotely from the ground and photographed by an Apogee camera crew on board a third, real helicopter.



Model pilot David Nieman hovers one of the choppers over the runway at Thule.

shinier ones. We also made the refueling system for that model. *The Bear* had a piece of brass tubing coming out of its rear, and then one of the 21 -inch Firefoxes was also rigged with a piece of tubing coming out of its nose. Each tubing section was about a foot long, and the tube of the Fox was just slightly smaller in diameter than the tube on *the Bear*, so that they'd nest together. All we did was



Producer-director Clint Eastwood checks a camera angle on one of the helicopter miniatures destined for

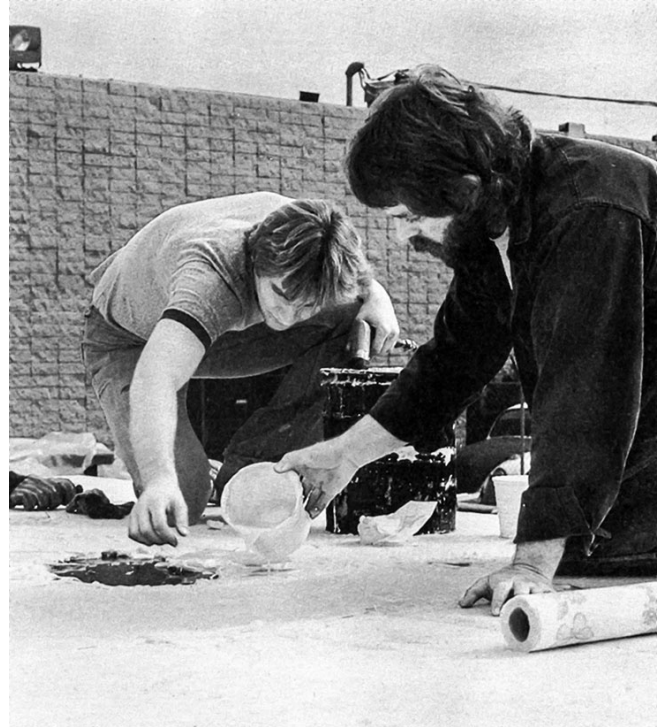
solidly lock off the *Bear* and put the *Firefox* on a motion control rig, and join the tubes together. No matter where you moved it — they were both on ball joints — the tube would take up any action of the movement between the two planes, side to side or up and down.”

destruction when Gant passes over a Soviet missile. The miniature of the Soviet missile was built by the same team of model makers that built the miniature of the *Firefox*’s flight deck.

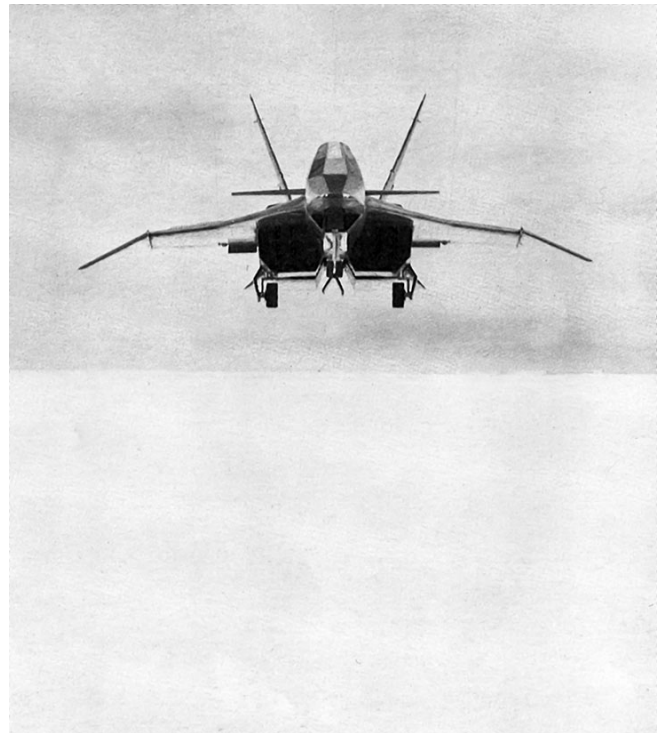
“We came up with a new wrinkle for the *Bear*’s props,” said Roger Dorney. “Usually when you’re shooting a propeller plane against a blue screen, it’s difficult to do convincingly because of smear. So instead of shooting that bluescreen, we shot the *Bear*’s props with the UV system. First we took the props off and shot the matte pass. Then we shot the beauty pass, with the props on and turning by means of a small electric motor. In making the mattes for the *Bear*, we just made the holdout matte from the matte pass and superimposed the positive image of the plane with its props on into the burn-in matte. Therefore, we had a DX in the prop area, which looks correct: but we didn’t have any DX in the matted area. That sold it. Nothing tricky, but it worked very nicely, because there was no smear or black edges to the props. This way, we also didn’t have to motion control the propellers, and it makes them that much more realistic. Essentially you only had the one pass, which registered to itself. A good looking shot.”

Gant’s own refueling procedure, however, becomes a bit more complicated. Landing on a water-locked ice floe, Eastwood brings his plane down next to an American nuclear submarine carrying a precious cargo of high-octane fuel. For those shots of the sub cruising under the arctic ice, stock footage from *Ice Station Zebra*, highlighting the large miniature submarine built for that film, was resurrected. Once the sub begins thrusting its conning tower through the ice, though, Apogee and *Firefox*’s first unit took over. A full-size conning tower mockup and the full-scale *Firefox* were all photographed at the Montana location for the live-action footage. However, those shots showing the conning tower from an aerial perspective, or of its breaking up through the floe itself, required miniature work — again in the Apogee parking lot.

“We made a twelve-foot by twelve-foot set piece of the ice floe that covered the top of a six-foot-square water tank that was four feet deep. Then we cut out a six-foot by six-foot hole in the center of the floe, hung chicken wire in that, and next cut another hole in the chicken wire about four inches bigger than the sub’s conning tower — which was about eighteen inches tall and six inches wide. Then we poured about ten gallons of paraffin on top of the water, in sheets and in different layers, letting it all cool so that it would crack in interesting ways. We next covered the entire set in microballoons for our snow. For wind, we turned on a small fan. Marty Kline painted a cyclorama in the background behind the floe, and small forced perspective icebergs were



The miniature aspects of the ice floe sequence were filmed entirely in the Apogee parking lot. Gary Rhodaback and Grant McCune pour layers of paraffin wax on water to simulate ice for the shot in which the American submarine surfaces from beneath.



Firefox takeoffs and landings were effected with an overhead wire rig and some supplemental radio control.



Jack Anderson, John Dykstra and David Scott film a takeoff.



Dykstra checks a low-angle shot as the Firefox comes to rest only inches from the edge of the floe.



For inserts, a snorkel lens was affixed to a 16-foot representation of the aircraft's underbelly, which was then mounted on a Titan crane and physically "landed" at speeds of up to thirty-five miles per hour.

made from foam and placed in the rear.

"The water tank already had a push-rod in its bottom, to which we attached the conning tower. We'd roll camera and then use that push-rod to force the tower up through the paraffin. It took us about thirteen tries to get it right. Something always went wrong. Either there would be this silly little top hat of wax sitting on top of the tower, or else there would be a sluice of micro-balloons streaming down one side."

The ice floe itself was also a miniature, one of the largest built for the film. It too was shot in the Apogee parking lot, and also had the distinction of being the last model effects sequence filmed for the project. "The ice floe model was the final answer to the radio-controlled *Firefox* problem," McCune remarked.

Not only the ice floe miniature was used for this scene, however. As Gant begins his descent, he looks out of his cockpit and studies a front projected process plate taken during the Thule shoot. For the point-of-view shots seen from the belly of the plane as the *Firefox*'s landing gear touches down

on the snow, the sixteen-foot MiG was hung from a Titan crane at Glasgow and “landed” on the snow. Most of the rest of the sequence, however, was done in miniature.

“The plane we landed on the floe model was cannibalized from the bodies of one of the 63-inch radio-controlled Foxes,” McCune explained. “I reworked that by putting in new electric engines directly connected to the landing gear, to which Bill Shourt also added a small chain-driven system. On the ground, the plane’s speed and direction could be controlled remotely, as well as some of the plane’s normal functions, such as moving the flaps and spoilers. The last conversion was to install two ducted model airplane fans and hook up small electric motors to them. When the Fox model touched the deck, these fans would then blow out our microballoon snow in interesting patterns; they could also be reversed to suck it up through the intakes.

“As for the large ice floe model itself, this was a perfectly level 80-by-24-foot table, which we covered with drywall and plaster so that it was nice and smooth. A cyclorama was erected along the back wall of the facility — one that was about eight feet tall and a hundred feet long — as well as another that covered the end wall, and was twenty-four feet long.

“To land the 63-inch Fox, we decided on a wire rig. We took a pair of giant forklifts and made a dual cable rig that had two cables running side-by-side, two feet apart, sloping to about five feet above the center of the table. A carriage was then hung from those cables, and from that carriage we hung three wires, one to each wing of the *Firefox* and one to the nose. The nose wire was motorized so we could raise or lower the nose by radio control. For the actual miniature landing, we would simply drag the *Firefox* up to one end of the cable and let it go. We kept lowering the cables until the back wheels barely touched the surface of the table, and we’d then drop the nose onto the deck. The takeoff involved much the same sort of thing. The plane would fall, making three-wheeled contact with the table; and then we’d lift the nose wheel just before the main gear lifted off.” Of course, the



Reverse bluescreen Firefoxes composited over Lear jet background footage shot in Greenland.



A Western Airlines 727 flight simulator served as the cockpit interior of a Soviet jetliner which is buzzed by Gant shortly after his theft of the Firefox. A blue screen was erected outside the simulator, and into the window

areas a real sky and reverse bluescreen model were composited.

liftoff portion of the touch-and-go maneuver was all that would be used in the finished film.

During the landing, the miniature *Firefox* skids to a halt inches away from the edge of the ice floe, barely missing a plunge into the icy water beyond. “For that,” McCune explained, “we took the end of that ice floe table and attached a four-by-eight-inch tray that we’d painted black and filled with water. Then we waxed up to the edge of the table to make it look like broken ice, and put some more of this wax on the bottom of the tray so that you could see ‘ice’ under the water. A small fan was mounted off camera to make ripples on the water; an electric sander was also mounted underneath that set to make the ripples more interesting. Our same radio-control plane was used for this shot, but we kept overshooting its mark and running it into the water, So we tightened up the angle of the shot a bit, and I just *pushed* it into frame — by hand.”

Despite the labor involved, the ice floe landing and takeoff scenes would later become something of a critical *cause celebre*, one of the most criticized effects sequences in the film. “Some of those shots were marginal,” John Dykstra admitted. “What it came down to was that, obviously, we couldn’t do it bluescreen — not when you had the plane’s wheels touching down and smoke effects. And we were stuck with matching previous footage that was heavily overcast. To match that up, we had to silk over the entire parking lot, cutting down on and diffusing the light. And whatever parts I see as not working in those shots were because the lighting was very low-contrast. Miniatures are very hard to shoot when they’re lit that way, because they need to fully match the highly reflective surfaces featured elsewhere. I had hoped that we could have shot those scenes in a broad sunlight environment. We could have gotten convincing shadows and the like under those conditions.”

The other major *Firefox* miniature included in the ice floe sequence was the sixteen-foot-long, quarter-scale MiG which could boast of only a detailed undercarriage. Suspended from a Titan crane, the large model was hydraulically operated and sported working landing gear capable of retracting into the plane’s belly. This was also the only miniature which actually “landed” on real ice and snow.

“The quarter-scale was equipped with a high-speed VistaVision camera pointing down through a right-angle snorkel lens,” said McCune. “We used it during February and March of 1982, during our stay in Montana. It was quite heavy. The model itself — with the hydraulics package designed by Bill Shourt — weighed about five hundred pounds. It could roll and pitch and had shock-absorbing wheels that were culled from motorcycle shocks. The crane was driven up to about thirty-five miles per hour during those shots in the movie when you can just see the wheels and belly of the Fox coming down on the snow. We had to move that quickly in order to get everything to work in conjunction with the hydraulics package. We had the ship suspended from the boom, and everyone was on the front end of the crane. We’d get up to speed and lower it down and run the hydraulics to get a little roll and pitch. Finally, we would push the rear wheels onto the ground; then we’d cram the front wheel down. That snorkel lens was certainly banged around, especially when the Montana ground cover became slushy. It was pretty hot the day we decided to shoot those scenes and the snow turned soft. Every time the wheels would touch ground, that slop would wipe out the lens.”

After Gant's theft of the *Firefox*, much of the action occurs in the cockpit of the plane, with Eastwood speaking into an onboard flight recorder. These cockpit scenes highlight John Dykstra's prime special effects dictum — "The best effects are those that people don't know are special effects" — to an astonishing degree, for *all* of these shots are the result of front or rear projection process photography. Not a single shot of the airborne Eastwood in his cockpit was photographed in true sunlight — all were done on stage.

The incredible verisimilitude of *Firefox*'s cockpit scenes — perhaps the film's single greatest technical achievement — begins with the believability of the cockpit itself. Actually, three of these "mockpits" were constructed for the film. The first was inserted into the full-scale plane, and equipped with detailed instrumentation. The second was embedded in a fifteen-foot shell of the MiG's nose section, a separate piece which McCune had pulled from a mold of the same area on the full-scale *Firefox*. This second cockpit was used primarily at The Burbank Studios in a large soundstage that was rented out for most of *Firefox*'s front projection shots, "This specific cockpit had been designed to only be seen from the outside looking in," McCune explained. "As a result, it had almost no working detail inside it — only some installed lighting that reflected back on Gant's face. The nose shell was also equipped with small, forced perspective tail fins that stuck up above the cockpit to give the illusion of a full-size ship when viewed straight-on. Whenever you saw a tight or medium shot of Gant in the air with this big gray body around him, that was the front projection cockpit."

But the most impressive cockpit by far was the third one, used for *Firefox*'s extensive insert photography. During Gant's flight, there are many shots of the *Firefox*'s dashboard, filled with sweeping radar screens and computer readouts, all shot on stage at Apogee with the insert cockpit. "The insert rig was fully detailed," said McCune, "including an F-14 practice seat that we borrowed from Edwards Air Force Base. The insert cockpit was also equipped with a complete avionics unit supplied to us by Tom Hamilton of the Bendix Corporation. *Everything* worked in there. Mark Gredell was responsible for those insert scenes; and when you see a hand or a foot in closeup against the dashboard, you know you're looking at that third cockpit. Occasionally though, even in a closeup, you'd see out of the window at the same time. In that case, they rear-projected a process plate on a screen outside the insert cockpit, which entailed a hideously tough lighting job. At the same time, there were usually two rear-projection 35mm process projectors shining onto the computer readout terminals.

"To control the onboard instrumentation, Richie Helmer built a small two-by-two-foot dashboard replica and connected it to the instruments within the larger cockpit. We only had to spin a knob on the small dash, and the larger one would respond at the same time. You see, an electromagnetic device like a compass has an electronics unit that takes what it sees from the airplane's antennas — a microprocessor unit that then tells a small motor where to place the indicator. By taking a transmitting motor and running wires to the instrument's motor, you can cause the instrument motor to react synchronously. So turning a knob on the miniature dash would recreate the same instrument position on the large one."

However detailed the insert cockpit, it was with the fifteen-foot nose section version that *Firefox*'s excellent front projection effects were utilized. "I could use the interior of that specific cockpit for

outward-looking shots by just slipping the camera in there,” said John Dykstra. “When a ‘God’s POV of Gant was needed, we were in a front projection situation that required us to be looking in on him while simultaneously recording some or all of that fifteen-foot shell. For those, we were shooting fifteen to twenty feet up in the air in front of a large Scotchlite screen — with the shell mounted on either a gimbal or parallel.

“I’m quite proud of our new front projector. Don Trumbull designed it, and it stood up to a real trial by fire on this show. It was an 8-perf VistaVision process front projector with a relatively small wattage lamp — a thousand-watt incandescent. The system utilizes a highly efficient optical path, and that’s why we get so much light out of it. It’s also very lightweight, about 250 pounds. This allows a great deal of flexibility, because you can put it on a Zeus crane, or even a stage crane, and get it up in the air to position the projector wherever you want. You’re not tied down to big parallels and all the other accessories that usually limit you during front projection work. The image quality is quite good, too, because the optical system incorporates copy lenses that are very, very sharp. I can go wide angle and use a 35mm projection lens at the same time.”

The *Firefox* front projection system further incorporated a moving key light to enhance the realism of the process shots. “The moving key light is a particular technique we’ve used before,” Dykstra continued. “Basically, the key light was mounted on a fifteen-foot pole, with a bearing in it, so that two men could manually move it in concert with what was happening on the background plate. This key light rig was a real monster — one of the reasons why we needed the room provided by a large soundstage like the ones at TBS. And, of course, we needed that space for our lighting requirements as well. Anyway, we’d take a look at the background plate and if the plate rolled to the right — and, of course, the camera was locked off at this point — we moved the key light to the left, as though Gant was actually rolling over and the key was moving around him. This cast shadows on him, and gave some interesting reflections to the work. Bruce Logan was also responsible for the effectiveness of that work, and it was his lighting, in concert with some new tricks that really made the front projection material a success.”

Apogee’s VistaVision process projector, which sat underneath the required camera, used the camera and projector all in one movement. It was also lightweight enough to be set in virtually any position — over Eastwood’s shoulder, below the process cockpit, to the side or front of it, and so on. “To create the helmet reflections, we didn’t use a second projector,” Dykstra said. “Instead, a rotating drum system — which simply shone that light across a piece of bounce-light white muslin — was hung over Clint’s head, giving the impression of images moving across his faceplate.”

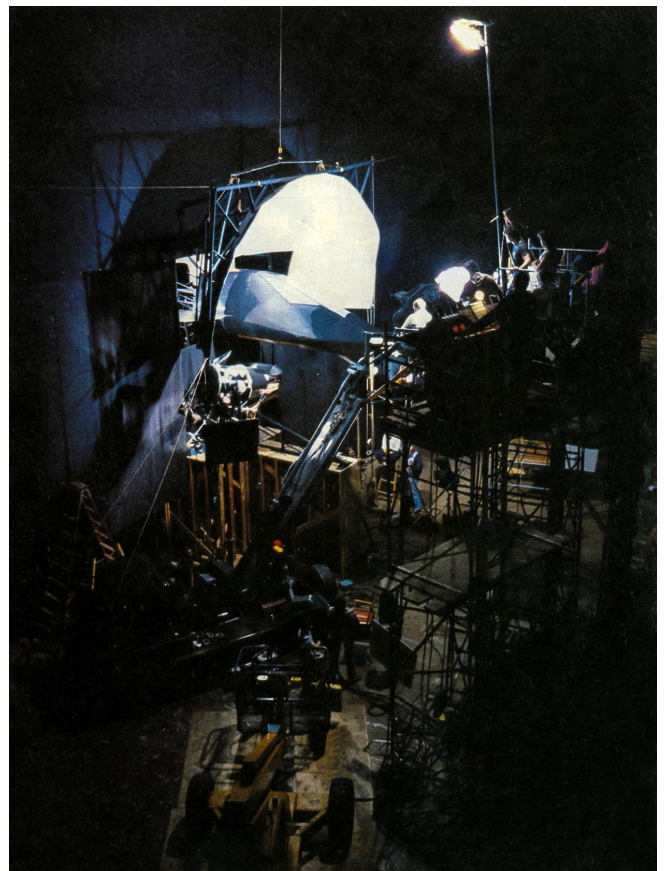
About three hundred process shots were done *in toto* for the *Firefox* project; but once the Malpas editorial department winnowed these down, there remained approximately seventy-five front projection, forty-five rear projection, and a number of mixed FP/RP shots in the final print — a hundred and fifty in all.

The *Firefox* sequence most worthy of an “event” picture — its special effects showcase — is certainly the ice trench chase. Though criticized in some circles as being a mere historical echo of the Death Star power trench scenes in *Star Wars*, the ice trench footage was still the most complex Apogee-generated effect in terms of miniatures, opticals and special motion control rigs.

To visualize the fictional quarter-mile wide, 3000-foot crevasse through which Gant and Voskov twist and turn during their final conflict, McCune and company were first obliged to construct a 120-foot model of the trench. Built up from twenty-two separate ten-foot-long by five-feet-tall sections, each trench piece was first made from wooden frames and then covered with muslin, onto which a two-foot thick layer of polyurethane foam was sprayed. Once hardened, the model crew took meat cleavers and hacked the sections up into rough-shaped valleys and ridges. A sandblaster was then rented, and the sections were further blasted into more eroded-looking shapes. At this point, a mixture of silicone microballoons and other substances was shot onto the assembled model and later washed down with hoses. “Finally,” said McCune, “we had reasonable sides on the trench. Then we took it up to the Van Nuys Airport where we had a good horizon.”

Filming the modular ice trench model — which could be broken apart, reconfigured and redressed with different canyon details, as needed — posed a number of motion control problems. To adequately suggest the peril facing an airplane in tight spaces, it was necessary to employ a motion rig which could be used on tracks during the outdoor shoot — negating the field control unit. Also, the fact that Dykstra and Shepherd had decided to stage the avalanche and other canyon effects set off by the two *Firefox* shock waves in real time required a combination of motion control plus high-speed photography. “That was a different proposition from anything we’d ever attempted before,” said Bob Shepherd. “So we came up with a complete new system we dubbed our trench rig. It could accept a number of cameras, including a VistaVision high-speed capable of getting up to about 72 frames per second. Actually, it was built to get up to 96 frames per second, but its movements weren’t too reliable at that speed. Anyway, all of the trench miniature scenes — Gant and Voskov’s POV shots, the God’s POV shots, the avalanches and explosions — were shot at speeds from about 24 up to 72 frames per second.”

The boom motion control trench rig was equipped with 128 feet of track. The rig was also capable of six axes of camera movement. An intriguing fact was that the rig was also capable of speed. The camera on the boom arm was hung over the trench with a 90-degree snorkel lens sticking down into the canyon slit. The remainder of the wheeled unit ran on its track directly alongside the extended miniature. Al Miller had provided a powerful DC driven motor — with approximately thirty horsepower — for the rig, which could drive the trench unit upwards of fifteen miles per hour. Moreover, it could go from a dead halt to full speed in only six feet. “Our normal speeds were about twelve feet a minute,” said Shepherd, “so that trench rig was really moving.”



To insert convincing skiescapes into the many cockpit shots, a full-size nose section was mounted at varying attitudes in front of a Scotchlite screen, with Apogee’s

Mark Gredell, Pat Harrison and Paul Johnson contended daily with this hybrid system. The VistaVision camera was always mounted looking straight down into the periscope lens, which made a right-angle so it was facing down the trench. The entire rig could also rotate. Rolls were accomplished by rolling the film plane on center, and pans by panning the camera in the support frame. "For an actual trench rig shot," McCune explained, "you'd program a couple of moves and let the motion control plan out what you were going to get for the rest of the axes. Oftentimes those moves were a little less than wonderful, so you'd go back in to try and hand-plan them. If you randomly programmed the moves with the joystick, you often got more articulate-looking shots."

lightweight front projection system mounted on a stage crane for maximum flexibility. Because of spatial requirements, the cockpit scenes were shot on a stage at The Burbank Studios.

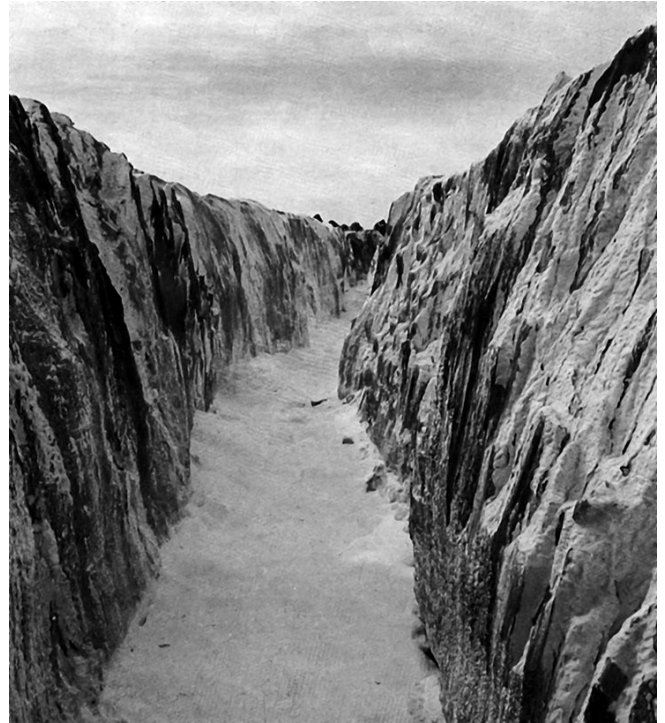
The avalanches on the ice trench model were executed by burying small squibs in pre-hollowed depressions on the canyon walls, and by the judicious use of air cannons. Since the motion control shots were also being filmed in high-speed, there were moments when the crew would simply dump a bucket of micro-balloons and other material over the side of the trench as the camera moved close to the point of contact. "We shot for about six weeks on that miniature," said McCune. "It went very slowly. The main problem was the weather. We had established a moderately overcast sky without hard shadows for most of the shots in Greenland and Montana, so we had to wait around for the weather in Van Nuys to match up to that. Otherwise, we had to shoot early in the morning or late in the afternoon."

The ice trench sequence also posed problems for the stage crews filming the model aircraft. "The ice trench had been preshot with all the moves and explosions in it," said John Sullivan, "but in programming the stage model and trying to make it fly correctly, the Firefoxes looked as though they weren't actually negotiating the trench walls. Instead, they looked as if they should have been smashing into them. We overcame that through creative programming.

"Here at Apogee we shoot what's called an RAR film. It's an



Electronics expert Paul Johnson adjusts the boom arm in preparation for an ice trench shot. As configured, the snorkel-lensed camera rig could move upwards of fifteen miles per hour through the trench under motion control. Though most motion control work is done at slow frame rates, because of explosions and avalanche effects the trench plates were shot as high as 72 frames per second.



A section of the 120-foot trench constructed by the Apogee model shop.



Gant and Voskov careen through the trench.

ester-based stock which gives us a negative image; so if we have a white plane up on the model mount and we mask everything off, we're left with a black plane on the film and a white background. We can then overlay this with a background plate on a registration viewer Moviola, and study how our move is in relationship to that plate. It just took a number of time of doing that — of programming and then shooting the plane onto RAR stock and bipacking it with the background — until everything worked the way it should.”

With the stage photography complete and the background plates developed and waiting, it fell to Apogee’s optical department to undertake the crucial task of compositing *Firefox*’s special effects work. No matter how well lit the model or how well controlled the plate, optical must put these elements together in such a manner that blue spill and matte lines are kept to a minimum. Apogee’s optical supervisor, Roger Dorney, began putting together *Firefox*’s opticals in October 1981. He was assisted on this by a five-man crew — cameramen Bruno George and Jerry Pooler, line-up assistants Paul Bolger and Mike Sweeney, and optical lab technician Rick Gilligan. “One of the optical problems on *Firefox*,” said Dykstra, “was that once we put our cloud plates and stage models

together, we would also have to succeed in getting the mattes down to where we had some aerial perspective. That was a real bitch.”

“My problem with *Firefox* was that it wasn’t a night shoot,” added Dorney, “and that it wasn’t done over a star field. Even though the Fox itself was black, you’d pick up terrible matte lines if you were going over a white or blue-white field of clouds. That presented a major set of problems. Basically, I think the UV system was the thing that helped the most through this, being able to be that close to the original photographic generation. It helps to be as close to the original generation as you can, simply because of the swelling and contraction of the matte itself.”

Firefox also has its subtler optical moments, such as the clever means by which the stage model Firefoxes were made to disappear behind clouds in the background plates. “To get some of those shots,” said Dorney, “which I thought were really nice, we first tried just wiping the Fox into the edge of the clouds. Unfortunately, that’s just what it looked like — a wipe. So we got back down to a simple fade-in, taking care to keep everything in sync. When the *Firefox* slips behind or emerges from a cloud, we just faded in the image. And, of course, when it’s behind the cloud, there really isn’t anything there at all. There’s nothing tricky about that, just a matter of syncing it.”

Not all of the opticals in the film please Dorney, however. In fact, the Tupelov “727” — which began life as an off-the-shelf model kit — was a particularly vexing optical proposition. “We had tried to get the 727 to blend into the background,” Dorney explained, “which was a flat, low-contrast plate with a lot of clouds in it. Unfortunately, the 727 was low-contrast, too. We didn’t run into this situation too often on *Firefox*, because most of the low-contrast plates were bald-type skies or had visible clouds with lots of edges to them. But this shot was low-contrast and had a lot of clouds in it. So what you see punching through the Tupelov are the edges of clouds. We were forced to use a thin matte to make that shot look realistic, but what we then picked up were the edges of the clouds coming through.” Failures and triumphs notwithstanding, *Firefox* certainly presented an unusually heavy optical load. In all, there are more than 134 composites in the film.

The Apogee animation department — headed by Harry Moreau, with assistant Angela Diamos — also contributed to *Firefox*. However, unlike a project such as *Star Wars*, the animation requirements for *Firefox* were minimal. Working with a Canadian version of the Oxberry animation stand, Moreau produced backlit animated tracer bullets, ten minutes of radar screen imagery, and fifteen minutes worth of the animated artificial horizon seen on the *Firefox*’s six-inch diagonal CRT screens — accomplished by a bipacked version of streaking and slitscan photography.

Moreau also produced the rearward defensive pod that Gant jettisons during the climactic dogfight — an explosive fireball which is sucked up into Voskov’s venturi passages. “The pod was a bottom-lit affair effected with what I call a scratch filter,” Moreau explained. “Most people call it a star filter, but what I do is simply take a cel piece and throw it on the floor and walk over it a couple of times. That creates a different ‘star’ pattern every time. And by overexposing Voskov’s venturi hole for two passes — one pass for the interior of the hole and another pass with the scratch filter on it, simply matching the stage model with the scratch filter — I obtained an interesting flare effect.”

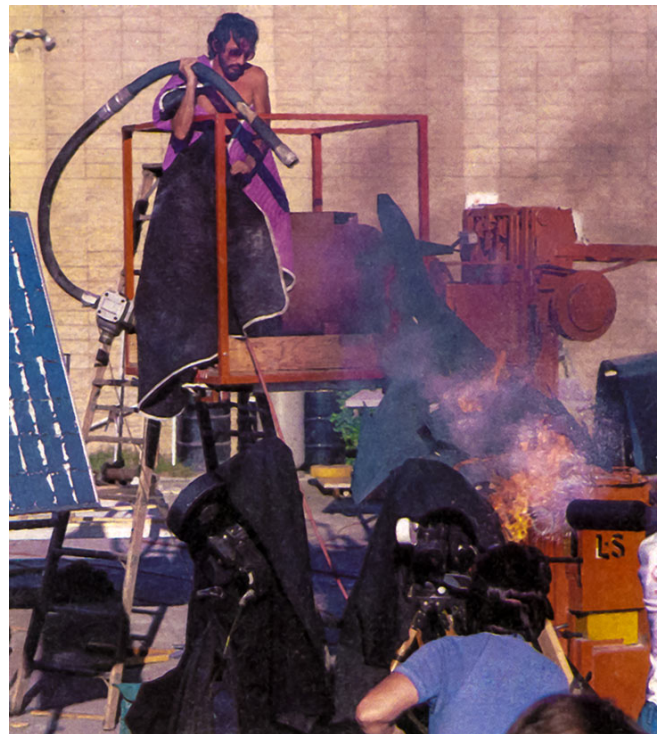
Before Voskov’s final defeat, however, he and Gant lock horns in a deadly dogfight. Most of the movements executed by the planes during this sequence are fast and jittery, accentuating the MiGs’ incredible speeds and maneuverability. All three basic stage model sizes were used throughout the

dogfight, which required certain motion control delicacy as well. “Sometimes we had to slow down our shooting rate so we didn’t overdrive the system during the dogfight shots,” said John Sullivan, “but the model roll was the main problem, We usually have a 300-to-1 gearing on them, but for these scenes we ended up changing that to 150-to-1, which helped compensate for the speed at which we had to roll the stage models. Personally, I would like to have made smoother moves on the planes, but the high speeds of the plates required a hard, fast movement — and that was what John and Clint liked.”

During the dogfight, a number of missiles are fired. Various techniques were used for these missile shots. At first, the MiGs’ missiles were animated; but that was ultimately dropped in favor of other techniques, including motion-controlled models. “Our animated missiles came out quite well,” said Moreau, “but we couldn’t produce them quickly enough, or match them up to the stage models quite as well.” As McCune elaborated: “We made scads of miniature missiles. Some were four inches long, some eight inches long, some a foot and some four feet long. Some were carried around in the live-action, some were hung from the



Reverse bluescreen Firefox composited over cloud background — with cel-animated tracer bullets by Harry Moreau and Angela Diamos.



~~Close-up of the explosion of Voskov's plane as it is shot at by the Apache. The explosion is very large and the flames are very bright. The explosion is very large and the flames are very bright. The explosion is very large and the flames are very bright.~~
Close-up of the explosion of Voskov's plane as it is shot at by the Apache. The explosion is very large and the flames are very bright. The explosion is very large and the flames are very bright. The explosion is very large and the flames are very bright. Longer shots were done on wires at the Sepulveda Basin in Los Angeles.

sixteen-foot model, and some were launched from the 63-inch model. We also used some on the helicopters. For the closeup of a missile dropping off from under the wing and then flying away, we used the foot-long missile up against the sixteen-foot plane. That was a motion control shot, and the drop and takeoff were separate elements. As for the box where the missiles were housed, the original idea had been to simply have the missiles hanging under the wings. I saw this as a problem. For one thing, all that crap hanging down would have made the radio-controlled Foxes that much more difficult to fly; and for another, it just didn't look like a Mach 5 plane with all this stuff hanging on it. Also, small appendages make bluescreen photography difficult. So we designed boxes which folded out from the lower engine housing. The doors folded up against the underside of the wing, and then you'd see two or three missiles hanging there."

Not all of the *Firefox* missiles are seen as distinct entities. Some merely appear as blazing pinpoints of light. For these shots, cameraman Jody Westheimer utilized a standard quartz reflector bulb and a formed, spherical glass mirror to achieve the proper effect. The mirror itself was stationary. Utilizing a full forty-eight feet of track, Westheimer then made multiple passes of the reflected light with a stage motion control rig while panning the camera and forcing the image across the frame. This resulted in the illusion of the blazing missiles coming directly towards the viewer and the composited stage *Firefox* models.

The visceral highpoint of the dogfight sequence has Gant desperately slamming on his air brakes and somersaulting *underneath* Voskov's *Firefox*, which then harmlessly screams above and past him. "That particular movement had been planned out well in advance of the stage photography," said Sullivan. "The background plate on that was executed by Dave Newell literally spinning the Astrovision camera while Clay Lacy was simultaneously rocking the Lear, giving Gant's plane the illusion of an out-of-control spin as it goes down. Later, on stage, Doug Smith and I programmed the motion so that it looked as if a 21-inch ship was performing those incredible rotations. There was no special model rig involved there — just a lot of tedious, standard programming to get the look right."

A double exposure was laid onto the footage of Voskov's exploding plane, combining Richie Helmer's pyrotechnics with a Greg Heschang pigment-in-water effect. The actual destruction of the *Firefox* stage model was filmed at the Sepulveda Basin in Los Angeles. "We rented a long arm-crane," John Sullivan recalled, "and suspended a 63-inch model on thin wires off of that crane, and further connected it to a cable running down to the ground. We chose our frame angles so that both the wires and cable weren't visible. Then we let the plane drop down the cable, which triggered off the charges, so that halfway down, the stage model blew up. We had another three-camera setup for that shot."

With the explosion of Voskov's plane — and after nearly two and a half hours of screen time — Mitchell Gant has finally completed his mission. To signify success, Gant puts his *Firefox* through a victory roll before triumphantly flying off into the clouds. John Sullivan photographed these final

two shots of the film, utilizing a nine-inch stage model, a 20mm lens and some “graceful, flowing programming that would give the Fox a stylish sign-off. I really wanted to make it look like Gant was in full control of the ship there. It took about a day and a half to program that shot. I also worked hard on the lighting, using rose-colored gels that kicked some nice highlights from the ship.”

Apogee completed the effects work on *Firefox* in early July, only days before the film’s release. However, the schedule had been met, and the budget kept within reason. Critical reaction to the film was predictable. Most reviewers zeroed in on Eastwood the actor and ignored the star’s firm directorial and producing talents. Surprisingly — perhaps because of Eastwood’s ongoing reluctance to let any of his projects receive extensive pre-release publicity — little attention was called to the fact that *Firefox* was a major effects film. John Dykstra, however, was philosophical about both the film’s critical reception and its impact in general.

“The truth is we were really trying hard to make the effects in *Firefox* not show. There are some shots that weren’t as good as they could have been — but then, there always are. Perhaps I got too carried away with staying far away from the planes, but I liked trying to make the Fox aerial effects look like *World War II* camera footage. But overall, we’re quite proud with our results on the film. Trying to make a real-looking environment with real-looking airplanes out of miniatures, in such a large variety of situations, just isn’t something that anybody’s ever done before. I think Clint Eastwood got the optimum amount of effectiveness for the money he spent.

“And working with Clint was a pleasure. At the beginning of this show I sat him down and said: ‘Look, this is going to be a mother. You’re going to come to hate this process material and a few of the other techniques that we have to use here.’ Because Clint has a reputation for keeping a project really moving, for going as fast as he can — which is something that I respect him for, because it keeps the crew moving and it keeps the spirit of the people working on the film alive. But once Clint understood the technical problems involved with *Firefox*, he accepted them and settled into it. He’d come to us and tell us what he wanted, be critical of the work we first did in response to his ideas, and then, when an agreement had been reached, would just relax and let us get on with it. Which was *marvelous*! He really did an excellent job in maintaining in situations where a lot of other people would have just come apart at the seams. Eastwood’s a sharp person and one helluva filmmaker. Any time he wants us to work with him again, he’s got us.”

Paul M. Sammon is a longtime film and effects writer whose work has appeared in a diverse variety of publications, everything from Omni and the Los Angeles Times to Muscle and Fitness magazine. He is currently writing and directing his first film, one he describes as an “effects-heavy” 16mm parody.

Firefox photographs copyright © 1982 by Warner Bros., Inc. All rights reserved. Effects unit still photography by Mike Middleton. Additional photos courtesy of Greg Jein. Special thanks to Percy Angress and Jon Erland.

